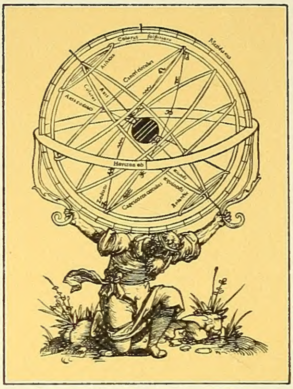

dx
oass
to pass

Austin G. Day
Seymour
Conn

Austin G. Day
120 Broadway
New-York.

GUM-ELASTIC

AND

ITS VARIETIES, WITH A DETAILED ACCOUNT

OF

ITS APPLICATIONS AND USES,

AND OF

THE DISCOVERY OF VULCANIZATION.

BY CHARLES GOODYEAR.

VOL. I.

NEW HAVEN:
PUBLISHED FOR THE AUTHOR.
1853.

PREFACE.

Gum-elastic, or India rubber, the subject treated of in the following pages, has become one of such general interest to mankind, that it is presumed no apology will be necessary for a publication of this kind; especially as little has heretofore been written, and little is generally known with regard to it.

If an apology were necessary, the customary one might with truth be made; the solicitations of friends and men of science, who have deemed the matters herein contained of public interest.

Notwithstanding the writer has been influenced by these considerations, he is willing that it should be distinctly understood, that one object he has in view in publishing this work, is to claim and secure for himself and his country, that which is emphatically his, viz., the credit of the discovery of the art of heating or vulcanizing gum-elastic, which renders it so generally useful.

Another object in view is to disseminate knowledge upon a subject which is of vast importance to the interests and welfare of mankind, and which is as yet but imperfectly understood. There is too little known by the best informed, in reference to the varieties of trees that produce the gum, and the countries where they are found, to satisfy the curiosity of most persons. It is hoped that by further investigation, there may be added to the work, at a future period, whatever is interesting, either on this or other portions of the subject.

The writer finds himself so identified with the subject, that he deems it impossible to give a correct history of the recent inventions in gum-elastic, without alluding to himself oftener than he could wish, by speaking of the trials and discouragements which he had to encounter during the first seven years of his experiments.

If the reader is disposed to charge him with alluding too often to incidents of personal history connected with that of the subject, he may plead in extenuation, that the whole period of seven years was but a continued succession of occurrences similar to those related, and equally entitled to narration.

However dry and uninteresting the literary contents may be, the aim has been to make the work useful, and, by the use of gum-elastic in its construction, to make the subject the better understood, from its being tangible, and emphatically a gum-elastic work.

If the author has succeeded better in the mechanical than in the literary execution of the book, it may be said that this is as it should be: his profession is not that of authorship; and further, for those who have both duties to perform, it is often less difficult to do things that are interesting, than it is to give an interesting account of them.

INTRODUCTION.

The writer has been impelled to issue this publication from numerous considerations. The novelty of the subject, the extraordinary properties of the substance, the numerous inventions and appliances growing out of it, the absolute necessity of imparting instruction and explanations to the great number who are constantly engaging in some branches of a manufacture with which they have previously had no knowledge, together with the inquiries which are constantly made by those who, from motives of curiosity or interest, are desirous of obtaining information on the subject; all these, and many other causes combined, have imposed upon the inventor an amount of labor to which his physical powers, being in feeble health, are wholly inadequate. Of a portion of this labor he hopes, in a great measure, to relieve himself by this publication.

It is believed that almost every person, in whatever situation in life, will find in this work something useful for him individually to know, a description of some article which would be of service in his occupation, or beneficial for the preservation of his life, health, or property; or else such a description of the properties and use of the various fabrics treated of, as may aid him in determining whether any particular fabric is adapted for any use or application he desires to make of it. While it will be discovered that the inventor is enthusiastic and sanguine on the subject of these inventions, he would not have attributed to

him the design to palm them upon the community, or recommend gum-elastic for uses for which the substance was never intended. Although the native Indians may drink it in the form of sap, with impunity, he is not so infatuated with the subject as to recommend it as an article of food.

It should not be worn next the skin, nor should one sleep enveloped by it; such are not the legitimate uses of the article. The extent and variety of the applications of this substance are sufficiently numerous and important, without stretching the list of them beyond reason. The views of the inventor, as regards these inventions and applications, are practically demonstrated in reference to them all, by the production of the articles described, with few exceptions, and of these, specimens are produced.

He presents no theory of a subject unsupported by demonstration, nor are these demonstrations mere specimens for exhibition, as of figures made in wax, or to gratify idle curiosity. It is generally well known that many of the articles are extensively used and highly approved; and the inventor believes that all classes of articles herein recommended, (if not each particular article,) will, in like manner, be found useful for the purposes for which they are designed. And as to the fact of a great improvement being made in gum-elastic, by the heating or vulcanizing process, and the peculiar and extraordinary properties of the substance made known, by the discovery of the writer, the truth is too well established, by seven years' trial, to admit of a doubt.

The inventor does not deem it at all presumptuous to present the idea of this subject, as being associated with the cause of humanity and philanthropy. When the great number of articles for the protection of life, health, and property, to which the substance and the fabrics treated of are perfectly adapted, are taken into consideration, the reader will admit that too much has not been assumed.

As regards his own pecuniary interests, under the present patent laws of the country, and considering, too, the uncertain

tenure of intellectual property, he is fully aware that his compensation, like that of most inventors or discoverers, may be but the scourge of litigation and of "hope deferred that maketh the heart sick;" and yet it may be reasonably expected, that when the plans of the inventor are generally understood and appreciated, a different result may follow, and a reasonable compensation be obtained.

This work, with the drawings and the descriptions contained in it, will at least have this good effect, to prevent much waste of time and money in litigation and dispute, between other persons as to what is new, in the application of metallized or vulcanized gum-elastic. It is a thing of almost everyday occurrence, that an individual makes an invention, that is actually such, as far as he is concerned, and it is supposed by him to be quite new, when it afterwards appears that it has been previously made by another, if not by many others long before. Time and money would have been saved, and controversy prevented, if the first inventor had published his invention to the world.

If the writer is thought to be extravagant in his predictions, with regard to the future use and importance of some things he has described, which are as yet hardly known to the public, it may be attributed, in part, to a presentiment of the future, quite common to inventors, with regard to the future usefulness of their improvements. These anticipations, in some cases, fall far short of what is subsequently realized, in the benefits conferred on mankind; and it comes to be often remarked, after the discoverers are gone, that they were not aware in their lifetime of what they had accomplished, and what benefits they had conferred upon others. This is no doubt sometimes the case; but in general, it may be presumed that the man who really understands his subject, can anticipate the future very nearly with regard to it.

Notwithstanding the allusions that are made in the following pages, to circumstances of trial and embarrassment for the want of pecuniary means to pursue his investigations, the writer

would be chargeable with ingratitude if he neglected to acknowledge, that while the public mind was filled with indifference or disgust in regard to any thing that related to gum-elastic, he was at different periods aided and sustained, not only by the sympathy of others, but by loans of money from numerous friends and acquaintances, without which the degree of perfection which has been attained in these improvements might never have been realized.

Fourteen years, in all, have been spent by the writer in experimenting, to complete a system of improvements and inventions, of various fabrics and articles growing out of the first discovery made by him; and to perfect and render practicable, the various processes and manipulations connected with the manufacture. Although many of the articles have for several years been advertised, and supplied to the public by the licencees of the inventor, and notices have occasionally been made by the press, of different improvements of the inventor, *yet he now presents, for the first time, the subject as a complete system.*

Much yet remains to be done in detail, and the manufacture, like all others of importance, will be one of constant development and progression; but it is believed that a great share of the important applications, and perhaps all the important fabrics, are described in the following pages, so that as a whole, the author is satisfied with his labors; and in this manner presents them to the world, hoping that they will also meet the just appreciation and the approbation of mankind.

I am indebted to Charles Smith, Esq., and Henry L. Norris, Esq., formerly of New York, for many interesting particulars relating to the Indian manufacture.

The former of these gentlemen has been, for many years, a resident and consul of the United States at Para. The latter, who was formerly engaged in the India rubber business in New York, is now an exporter of gum-elastic from Para, in connection with the house of Messrs. James Bishop & Co., of New York. These gentlemen have every opportunity of giving correct information on this subject.

In addition to whatever else this book may contain of interest to the public, it is designed as a specimen of the art of binding books with India rubber. The plates and maps are printed on India rubber fabrics, and a few copies, designed for public libraries, are printed on India rubber tissue.

CONTENTS.

VOL. I.

CHAPTER I.

CAOUTCHOUC, OR GUM-ELASTIC TREE.

CHAPTER II.

NATIVE GUM-ELASTIC, OR CAOUTCHOUC.

CHAPTER III.

INFERIOR GUMS AND RESINS.

CHAPTER IV.

EARLY HISTORY OF GUM-ELASTIC.

CHAPTER V.

METHOD OF GATHERING THE NATIVE GUM.

CHAPTER VI.

CLAIMS OF THE AUTHOR AS INVENTOR.

CHAPTER VII.

EXPERIMENTS OF THE INVENTOR.

CHAPTER VIII.

NATURE OF THE DISCOVERY.

CHAPTER IX.

GOODYEAR'S HEATED OR VULCANIZED INDIA RUBBER.

CHAPTER X.

MANUFACTURE OF VULCANIZED GUM-ELASTIC.

CHAPTER XI.

HEATED, OR VULCANIZED FABRICS.

CHAPTER XII.

PLANS OF THE INVENTOR.

CHAPTER XIII.

INVENTIONS AND PATENT LAWS.

CHAPTER I.

CAOUTCHOUC OR GUM-ELASTIC TREE.

The Ficus elasticus. Its growth and description. The Euphorbicea tribe. The Massaranduba. The Caoutchouc tree of Assam. Varieties of Caoutchouc, and its specific gravity. Dr. Ure's analysis of the gum. Remarks on trees producing gums resembling Caoutchouc.

A MORE specific and minute account than we are able to give, of the trees of South America and India, as well as other parts of the globe, which produce the genuine gum-elastic, would be highly interesting, as also an account of the peculiarities of the various trees and plants which yield a sap, and some of them a gum, that very nearly resemble gum-elastic in appearance, but which do not possess its wonderful property of elasticity.

From the accounts that are published, as well as the report of travelers, it is evident that there is a marked difference between the trees of South America which yield the genuine gum-elastic, and those of India, as well as a difference hereafter noticed in the gum which they produce.

We are informed by persons who have visited the regions where India rubber trees abound, that they are much more accessible in India, and on the western coast of South America, than they are in the dense forests of Brazil.

It is obvious that the warlike and indolent, or peaceable and industrious character of the natives of the different countries, must also affect very much the cost of the gum in the different countries where it is obtained.

It is undoubtedly owing very much to influences of this kind, that the gum from India and Borneo has heretofore been imported, on the average, at less than half the cost of that from Para.

The Ficus elastica, genuine Caoutchouc, or India rubber tree, is of the siphilla tribe, and is found in abundance in Brazil. It is the common growth of the forest of that country. It reaches to the height of from eighty to one hundred feet, and to about forty or fifty feet without branches, the trunk measuring from twelve to eighteen inches in diameter. The tree is tufted with a thick glossy foliage, and has a leaf resembling very closely the chestnut leaf, only larger and thicker, being about five inches in length. Like other trees, when in an open situation, the branches grow nearer the ground, and have a greater spread. The genuine gum-elastic tree has never been made to grow in the United States. The gum-elastic tree which is commonly exhibited in the hot houses of northern latitudes, does not yield the genuine gum-elastic, although it produces a sap that has exactly the appearance of that of the India rubber tree.

From Kidder's Travels in Brazil:—

" There are several varieties of trees, most of them belonging to the tribe Euphorbicea, which produce a gum of this sort. Another tree, not uncommon in Brazil, is the Massaranduba, which yields a white secretion, that so resembles milk in its qualities, that it is highly valued as an aliment. The trees yield this milk in great profusion; of which, when coagulated, a plaster is formed of the curd, that is deemed valuable. Their botanical character has never been properly investigated. It is presumed that there is a close affinity between the Massaranduba of Brazil, the cow tree of Demarara, and the butter tree of Africa. The sap of the India rubber tree is also sometimes used as milk, by the Negroes and Indians who work in its preparation. It is said that they are fond of drinking it, and that it was the custom among the Indians to present a bottle of it to every guest, at the beginning of one of their feasts."

From the Supplement to Ure's Dictionary we extract the following:—

" Hitherto the greater part of the caoutchouc has been imported into Europe from South America, and the best from Para; but of late years a considerable quantity has been brought

from Java, Penang, Singapore, and Assam. About three years ago, Mr. Wm. Griffith published an interesting report upon the Ficus elastica, the caoutchouc tree of Assam, which he drew up at the request of Captain Jenkins, agent in that country, for the governor-general of India. This remarkable fig tree is either solitary, or in two-fold or three-fold groups. It is larger, and more umbrageous than any of the other trees in the extensive forest where it abounds, and may be distinguished from the other trees, at a distance of several miles, by the picturesque appearance produced by its dense, huge and lofty crown. The main trunk of one was carefully measured, and was found to have a circumference of no less than seventy-four feet; while the girth of the main trunk, along with the support immediately around it, was one hundred and twenty feet. The area covered by the expanded branches, had a circumference of six hundred and ten feet. The height of the central tree was one hundred feet.

"It has been estimated, after an accurate survey, that there are forty-three thousand two hundred and forty such noble trees within a length of thirty miles, and breadth of eight miles, of forest near Ferosepoor, in the district of Chardwar, in Assam.

From Ure's Dictionary of Arts, &c. :—

"Caoutchouc. Caoutchouc occurs as a milky juice, in several plants, such as the siphonia cahuca, called also hevea guainensis cautschuc, jatropha elastica, castilliga elastica, cecropia pellata, ficus religiosa and undica, urceolaria elastica, &c. It is, however, extracted chiefly from the first plant, which grows in South America and Java.

"Its specific gravity is 0.925. It melts at 248° Fahrenheit, and stands afterwards a much higher heat without undergoing any further change.

"It has lately been employed very extensively in making elastic bands or braces. The original manufacturer of these elastic webs is a major in the Austrian service, who erected a great factory at St. Deny's, near Paris, 1803.

"Caoutchouc, according to my experiments, which have been

confirmed by those of Mr. Faraday, contains no oxygen, as almost all other solid vegetable products do; but is a mere compound of carbon and hydrogen, in the proportion, by my results, of ninety carbon to ten of hydrogen. Mr. Faraday obtained only 87° carbon."

From the foregoing extracts, and the testimony of individuals, together with the specimens of the inferior gums that have been imported, we have ample proof that there is a gradation of these productions, from the best genuine caoutchouc, down to those kinds that are quite non-elastic, all of which are obtained from the sap of various trees and plants.*

Some of these trees and plants yield a similar sap which does not inspissate, but which might possibly be made to do so by the use of chemical agents.

It becomes a matter of interest, and, in fact, of great importance, to ascertain whether some of these gums, that are considered inferior because they are not elastic, may not serve the same purposes as gum-elastic for the plating or coating of non-elastic fabrics. Among the numerous varieties of water-proof gums that are found in all equatorial regions, it is exceedingly probable that some which are not now known in the market, or even noticed in the countries where they are produced, will be found to answer the above purposes, and perhaps be less objectionable on account of odor than India rubber; and, like all other gums, resins, and bitumens that have yet been found, it may be presumed that they will be changed, either alone or in combination with caoutchouc, by the process of vulcanization; and it may with equal probability be assumed that none of them will be found which do not require to be divested of their native adhesive properties by the process of vulcanization, in order to render them generally useful.

* The tree which yields the genuine India rubber in Brazil, is very generally called the Seringa tree.

CHAPTER II.

NATIVE GUM-ELASTIC OR CAOUTCHOUC.

The Boracca of Brazil and varieties of gum-elastic. India gum. Its solvents. Mode of gathering. The Para gum. The virgin gum. Properties of the native gum. Extracts from scientific works respecting caoutchouc and its varieties. Gutta Percha.

"This substance is now indiscriminately called gum-elastic, caoutchouc, and India rubber. It is sometimes called by the Brazilians, boracca; but it is more commonly called by the Indians, seringa. The pronunciation of caoutchouc, the aboriginal name, is similar to that of cahuchee." It is found in most, if not all countries under and near the equator. The importation of this article has in former years been chiefly from the city of Para, in the province of Para, South America. Very recently the trade in it has extended to the western coast of South America, where it is said to be most abundant, and of the best quality.

The sap, when it exudes from the tree, is of a milky whiteness, about the consistence of honey, resembling that of the poppy or milkweed of northern latitudes, which also contain a minute portion of an elastic substance, very much like India rubber. It will not flow to any considerable distance from the tree, before it coagulates, or separates from the whey, or liquid part of the sap, and it is, therefore, drawn into clay cups attached to the tree, in the manner hereafter described.

There are three varieties of the genuine gum-elastic, among which, there is a marked difference, although it is not in the present stage of the manufacture, sufficient to cause any great difference in the quality of the goods made from them.

The first which I shall describe, is India gum. This has heretofore been imported mostly from the islands of Borneo,

Sumatra, and Java, and also from Assam. This gum is of a reddish, or flesh color. It contains —— parts carbon, —— parts hydrogen; the specific gravity is ——. It is soluble in sulphuric ether, and the essential oils. Turpentine or camphene is used in the United States as a solvent for manufacturing purposes, but naphtha has been more commonly used in England.

It has to this time been imported into the United States at about one-third the price of the manufactured bottle, and shoe gum from Para, or from five to eight cents per pound. Notwithstanding the extremely low price, it has not heretofore been in great demand, in consequence of the quantity of small particles of bark that are intermixed with it, amounting to about five per cent. of its weight.

It is evident from its appearance, that it is gathered by scarring the tree, and allowing it to flow down the trunk, and that it is afterwards stripped off and wound up in skeins or hanks, with particles of the bark adhering to it. These hanks are heaped in masses, in which state it comes as ballast with cargoes of light goods, teas, silks, &c.

Machinery has been recently applied with great success for cleansing this gum, at a cheap rate, yet it is to be hoped that it may hereafter be imported in a clean state, for it cannot be cleansed as perfectly as it might be gathered, and a very slight difference in this respect makes a material difference in the value of the article.

The second variety, caoutchouc, or gum-elastic, obtained from Para, *manufactured* by the natives, has always been esteemed the best, and formerly was the only gum which it was safe to re-manufacture; and even now, it is commonly considered the best, although in point of fact, it is not so. That from Para which is not smoked, and that which comes from the Pacific coast of South America, is equally good; and the virgin gum, when well seasoned, is better.

This gum contains 87 parts carbon, and 13 parts hydrogen; specific gravity, according to Ure, is 0.935.* It is soluble in the same way as the first variety. For some years past, the price

* It melts at 248° Fahrenheit.

of the manufactured or smoked article from Para, has remained at about the same, varying from eighteen to thirty cents per pound, according to its quality. It may be important to state here, that although some of the trees, like some animals, yield richer milk than others, this difference in price is not owing to any real difference, in the quality of any particular variety of gum, but depends on the degree of cleanliness, the age of the gum, or the length of time it has been gathered, as there is more gum in the same weight when it has been well dried, there being less moisture in the old, than in the new gum.

The third variety is that which is known in the United States as virgin gum. This flows spontaneously from the roots of the tree, and forms ill-shapen masses of from five to thirty pounds weight. The tree is the same as that which yields the second variety in South America. When well seasoned, or dried, it makes the best goods, and is more readily metallized or vulcanized than the other varieties. It contains ninety parts carbon and ten parts hydrogen, its specific gravity ———. It is dissolved by the same solvents as the other two varieties, but it is not so easily acted upon by them. When this gum has acquired great age, it is nearly impossible to dissolve that which is obtained from the oldest trees.

The virgin gum is of a much harder nature than either of the other two kinds. After being kept for several years it becomes, for a considerable depth beneath the surface, nearly as hard as horn or whalebone. The other kinds appear to season, and become more solid for about two years, and not to change materially afterwards.

The virgin gum was formerly imported into the United States at one-third the present price of the bottle and shoe gum, but for some years past it has not been much exported from Para. This fact, the writer is of opinion, is satisfactorily accounted for, in the chapter under the head of "method of gathering the gum," page .

PROPERTIES OF THE NATIVE GUM.

Native gum, or Caoutchouc, does not lose any of its valuable properties, by age or exposure to moisture. It is not materially injured, (although it is penetrated and considerably softened,) when immersed long in water. It is, however, soon damaged by exposure to a hot sun, which is the only injury those who are engaged in gathering or dealing in it, need to guard against, except that of getting foreign substances mixed with it. When left to coagulate with the whey, or sap, it contracts a tainted odor, and filthy appearance, and some persons have rejected it, on this account, supposing it to be damaged, when it is not. This is distinct from the natural odor of the gum, treated of in another place, and does no harm, as it is dispelled by the heat of the vulcanizing process.

The air- and water-proof quality of gum-elastic is one with which the public are well acquainted.

Great adhesiveness is another remarkable property of this substance. Where two surfaces of the gum are brought in contact, they are readily and solidly united, by the application of heat and pressure. When in large masses, after being sometime exposed to the atmosphere, it appears to be inadhesive, and indestructible, but when spread out into thin layers, on cloth or in sheets, it is quite the opposite. When any two surfaces of it are brought in contact, if perfectly clean, they adhere together even without pressure, so that they cannot be separated. It was losing sight of this fact, or not understanding it, that led to such mistakes, and losses in the early attempts to manufacture the article, in America. In cold, or even moderately cold weather, it becomes so stiff and hard, when of any considerable thickness, as to render it unfit for any use, where flexibility is required, without first being warmed.

The most remarkable quality of this gum, is its wonderful elasticity. In this consists the great difference between it, and all

other substances. It can be extended to eight times its ordinary length, without breaking, when it will again resume its original form.

There is probably no other inert substance, the properties of which excite in the human mind, when first called to examine it, an equal amount of curiosity, surprise, and admiration. Who can examine, and reflect upon this property of gum-elastic, without adoring the wisdom of the Creator?

In early life, on first obtaining a thin scale, from a newly imported bottle of the Indian manufacture, it occurred to the writer that if any method could be discovered of preventing the surfaces from adhering together, when brought in contact, it would constitute a beautiful fabric, for many purposes. The ideas of it then entertained, are already, more than realized.

The odor of the native gum, is very offensive to many persons, and has always been a great objection to its use. The writer does not profess to have entirely removed this objection, by his process of metallizing or vulcanizing, as described in another part of this work. Upon this point the reader will find more particular remarks under the head of "Metallic or Vulcanized Gum-Elastic."

Notwithstanding all the imperfections of the native gum, its use, in various ways, even before any of the improvements treated of in this work were made, had become almost indispensable to man. For erasing pencil marks, it was invaluable, and it had no substitute. The bottles, shoes, and toys made of it by the Indians of Para, were exceedingly useful. As a raw material for elastic threads, used in the manufacture of suspenders or braces, in Europe, and for the Macintosh cloths, it was highly valued, and extensively used.

The consumption of the native gum for such uses has become so general, that it will necessarily be a long time before it is entirely superseded by the substitution of the recent improvements, however much they may excel.

The use of the native gum-elastic, in varnishes, can never be interfered with, by these improvements, because the metallizing or vulcanizing process is not applicable to the substance in a

liquid state. The inquiry is often made, if gum-elastic, treated by these processes, will not make excellent paint, &c. The difficulties in the way of this are as follows: The process of baking in an oven or steam heater, with a heat of about 270° Fahrenheit, is indispensable for the improvement; and further, the great quantity of turpentine required to bring it into a state liquid enough to spread with a brush, would make it too expensive, for use, as a common paint. Another difficulty is that when dissolved, it ferments and spoils, when mixed with white lead, chromes, &c., to give the colors, unless it is baked, within a short time after being mixed. I make these remarks, that those who come after me, may know the difficulties they will meet, in experimenting with the substance for paints.

Reflection or philosophy would teach us that a substance, which is formed for the sustenance and growth of the tree, and is carried up by the warmth of the sun, would also be influenced by the sun and weather, when taken from the tree, and would not be substantial enough for man's use, without first being subjected to some great change. In the first attempt to manufacture this substance, this condition of the native gum seemed either not to be known, or to be lost sight of, as it was supposed by myself, as well as others, that to make the manufacture complete, it would only be necessary to restore to the gum its native qualities. It was at length found, that although the objections were much increased, and the gum made much more perishable by the re-manufacture, yet as soon as the nature of the article was well understood, these were found to be inherent defects in the gum in its native and best state. The mistake of attributing the failure of the first attempts to re-manufacture the gum in the United States, wholly to the dissolving of it, would naturally arise from the fact that before the manufacture was established, it had only come under our observation, in thick masses, such as heavy shoes, slabs, bottles, &c. In this state the apparent solidity and strength of the gum is of the most substantial character, and its defects, except that of rigidity, are not apparent; but upon being spread out into thin layers,

or the surface of a mass being made fresh, by cutting, the properties of adhesiveness and solubility are fully demonstrated. The French and English, in their first experiments, seemed to understand, better than the Americans, the true nature of the gum; they proceeded, at least, with more caution, and confined themselves to the safe and successful applications to which it was adapted at that time, as will appear in the chapter upon "Foreign Manufacture."

The following extracts from scientific works may be interesting to the reader:

From the Penny Cyclopedia, 1836.

Caoutchouc. "This remarkable substance is produced by many different plants. That which comes from the tropical parts of South America is obtained from Siphonia (or Hevea) elastica; and most other euphorbiaceous plants furnish it more or less abundantly. Various Urticaceæ yield it, especially Ficus elastica, and the rest of the genera of the Artocarpeus sections; Cecropia pellata has even been asserted to furnish a large proportion of the American caoutchouc, but this is doubted by Humboldt, because its juice is difficult to inspissate. In Papautla it is yielded by a plant called Ule, which the Berlin botanists call Castilloa elastica. Several Apocynaceous plants secrete this matter, as Urceola elastica, in Sumatra; a species of Nahea in Madagascar; and Willughbeia edulis, in India, but the latter is of a bad quality. Among Asclepiadaceous plants, Cynanchum ovalifolium is asserted, by Wallich to afford excellent caoutchouc at Penang."

"In South America the natives have long made water-proof boots of caoutchouc, and by imbruing cloth with the milky juice of the hevea have rendered it impervious to moisture."

From the Edinburgh Encyclopædia, 1832.

Caoutchouc: "This substance appears to have been introduced into Europe about the beginning of the eighteenth century, but nothing was known of the mode of its production until the year 1736, when M. de la Condamine presented a paper to the French academy, describing the tree from which it is obtained, and the mode of preparation."

"More recent observations have now determined that caoutchouc is obtained from two South American plants, the Hævia caoutchouc and the Jatropha elastica."

"Its specific gravity is 0.9335.

"Mr. Gough observed that if slips be plunged into cold water at the time they are considerably extended, they lose their contractile power, but if plunged again into warm water, or if kept warm some time in the hand, they become again elastic."

"Caoutchouc is used for various purposes,—balls, bottles, boots, torches." In Europe it is commonly used to take out the marks of black lead pencils, for syringes, bougies and catheters, elastic tubes and varnish.

From Rees' Cyclopedia, about 1810.

"In the Asiatic researches is an account by Mr. Howison, surgeon of Palo Penang, of a substance exhibiting all the properties of caoutchouc, procured from the juice of a climbing plant, the Urceolo elastica, a native of that small island and the neighboring coast of Sumatra. If one of the thicker and older stems of this plant is cut into, a white juice oozes out, of the consistence of cream, and slightly pungent to the taste. By exposure a short time to the action of the air, or still *more expeditiously by the addition of a few drops of acid,* a decomposition takes place, the homogeneous, thick, cream-like juice separates

into a thin whitish liquor resembling whey, and the caoutchouc concretes into a clot or curd.

"Cloth of all kinds, (says Mr. Howison,) may be made impenetrable to water by impregnating it with the fresh juice of the Urceolo. Boots, gloves, &c., made of this impervious cloth, are preferable even to those formed of pure caoutchouc, as they are more durable and retain their shape better. If a sufficient quantity of this juice could be obtained, it might no doubt be applied to a vast variety of important purposes."

An American gentleman who has taken much pains to obtain authentic information on this subject, remarks as follows:

"The first mention of India rubber as applicable to the arts, was by Dr. Priestley, in his Introduction to the Theory of Perspective, published in 1770, in which he speaks of it as a substance just introduced, and adapted to removing the marks of lead pencils from paper. He commends its use, and the vender of it, Mr. Nairre, instrument-maker, opposite the Royal Exchange, who sold cubical pieces of half an inch in size for three shillings sterling."

It is believed the article was first brought to Europe in 1730, by some French mathematicians, who had been making some astronomical observations in South America.

It is a very curious reflection, that the articles which have most affected the commerce and financial resources and condition of the nations of Europe, have been chiefly derived from the New World. We allude to the potato, to tobacco, the precious metals, and cotton, and another article has sprung into use which bids fair to be as important, Caoutchouc."

GUTTA PERCHA.

Its properties. Sketch of the history of its introduction into use in the civilized world.

When the chief discovery treated of in this volume was made, namely, the art of curing or treating caoutchouc by means of sulphur and a high degree of artificial heat, very few varieties of caoutchouc had been brought into the United States, and the author was unacquainted with the names, and even with the existence, of certain varieties which are at this time articles of common importation and use.

The number of gums which from their general properties may be called varieties of caoutchouc is considerable—and it is probable that from time to time new varieties will be discovered and brought into use. In foreign publications we meet with names of gums possessing similar properties which have not yet been seen in the United States; they are chiefly, if not universally, of Eastern origin—and appear to be found in nearly the same latitudes and geographical situations. Some of the names of the Eastern gums which may be termed varieties of caoutchouc are Gutta Percha; Gutta taban or tuban; Gutta girek or gegrek; Jintawan; Jelotong; Getah matah buay; Litchu. The author has not been able to procure specimens of most of these gums—but supposes from the descriptions of them occasionally met with that they are varieties of Eastern caoutchouc.

Gutta Percha is well known and is beginning to be somewhat used in the United States. Among its advantages as a material for manufacture are properties which it possesses in common with South American and other varieties of caoutchouc, namely, its plasticity and adhesiveness at certain temperatures—and its hardness at certain other temperatures. Its plasticity when warmed to a temperature of about 145° Fahrenheit renders it exceedingly easy of manufacture. It retains

its shape and is sufficiently hard for use at all temperatures below about 90° Fahrenheit. In its liability to stiffen in cold, Gutta Percha resembles South American caoutchouc. Gutta Percha also resembles South American caoutchouc in its resistance to injury by friction and percussion. It becomes elastic at certain temperatures. Its chemical composition is the same as that of South American caoutchouc, namely, 87 parts carbon and 13 hydrogen. It possesses similar powers of chemical combination with the South American gum. It is susceptible of the change called vulcanization by being suitably prepared and being exposed with sulphur to a high degree of artificial heat; and in some forms of vulcanization, and in some combinations, particularly in that called the hard compound, it may be worked with equal advantage with South American caoutchouc. It is to be remembered that we receive the South American gum after its having been once manufactured by the Indians—while we receive Gutta Percha not in a manufactured state, though it is frequently and generally, if not always, mixed with inferior gums or substances at the place of production, for the purpose of adulteration and greater profit. It is probable that the South American caoutchouc and Gutta Percha, when both perfectly pure and unmanufactured, and of the same age, resemble each other much more closely in their properties and powers than we are at present able to state with certainty.

Comparison of Gutta Percha and India Rubber, by Charles C. Page, Professor of Chemistry, National Medical College, Washington, D. C. From "Silliman's American Journal," vol. 4, second series, page 341.

Professor Page says:—"It is somewhat remarkable that the interesting substance, Gutta Percha, appears very much like the India rubber when rendered inelastic by exposure to cold. This valuable modification of caoutchouc (Gutta Percha) gives, according to Dr. Maclagan, by ultimate analysis, carbon $86\frac{36}{100}$, hydrogen $12\frac{15}{100}$; and caoutchouc, according to Faraday, gives carbon $87\frac{2}{100}$, and hydrogen $12\frac{8}{100}$. The Gutta Percha yields

by destructive distillation similar products to caoutchouc; like caoutchouc it is soluble in coal naptha, in caoutchoucine, and in ether, and insoluble in water and alcohol." Then follows a quotation from Dr. Maclagan's communication to the Scottish Society of Arts:—"When placed in water at 110°, no effect is produced upon it, except that it receives the impression of the nail more readily, but when the temperature is raised to 145°, or upwards, it gradually becomes so soft and pliant as to be capable of being moulded into any form, or of being rolled out into long pieces or flat plates. When in the soft state it possesses all the elasticity of common India rubber, but it does not retain this property long. It soon begins again to grow hard, and in a short time, varying according to the temperature and the size of the piece operated upon, regains its original hardness and rigidity."

August 31, 1847.

As Gutta Percha appears to be destined to become useful, as a variety of caoutchouc, in its vulcanized state, particularly in the form of hard compounds, the reader will perhaps find the following extracts from the "American Journal of Arts and Sciences," commonly called "Silliman's Journal," interesting, as giving a sketch of the history of the introduction of Gutta Percha into the manufactures and uses of the civilized world.

The first mention of Gutta Percha in Silliman's Journal, is in vol. 5, second series, page 289, (1847,) being an extract from the Lond. Jour. Bot., No. 61, Jan., 1847, p. 33.

This article attributes the discovery of the valuable properties of the substance to Mr. Thomas Lobb, when in Singapore, &c., &c.

Plant called *Sapotaceous* and *Bassia* is given as the name.

It states that Dr. Montgomerie first brought Gutta Percha into public notice. "He writes thus in the Magazine of Science, 1845, &c., &c.;—so long ago as 1822, when I was at

Singapore, I was told of Gutta Percha *in connection with caoutchouc.*" "There are three varieties of this substance :

Gutta Girek,
Gutta Tuban, and
Gutta Percha.

Dr. Montgomerie gives the localities where it is found.

The second notice of Gutta Percha in Silliman's Journal, is in vol. 5, second series, page 291, from which the following are extracts :—

"Gutta Percha. E. Soubeiran. (Jour. de Pharm. et de Chim., Jan., 1847.) The chemical relations of Gutta Percha are almost identical with those of caoutchouc. Separated from impurities by hot water, and from the accompanying resins by alcohol and ether, the substance was obtained in a state of purity by Soubeiran. Submitted to analysis, it gave carbon $87\frac{8}{10}$, hydrogen $12\frac{2}{10}$, while, according to Faraday, caoutchouc gave carbon $87\frac{2}{10}$, hydrogen $12\frac{8}{10}$.

"The action of solvents is also similar with the two substances. Water and alcohol have no effect ; ether and most volatile oils produce only imperfect solution. The true solvent is oil of turpentine, which produces a clear and colorless solution, from which the Gutta Percha may be obtained unchanged by evaporation."

The specific gravity of Gutta Percha is 0.9791—that of caoutchouc being 0.9355.

The third notice of Gutta Percha in Silliman's Journal, is in vol. 5, p. 433 ; concerning its applicability to modeling. Mr. Brooke, of Borneo, stated that an unlimited supply might be obtained from that country.

The fourth notice of Gutta Percha in Silliman's Journal, is in vol. 5, page 438, (1848,) being extracts from remarks upon the substance, by Thomas Oxley, Senior Surgeon of the Settle-

ment of Prince of Wales Island, Singapore, and Malacca. (Jour. Ind. Archip., Singapore, No. 1, 1847, p. 22.)

This article gives a minute botanical description of the tree, and of the mode of collecting the gum by the natives.

It gives a description of the *properties* of the gum, and considers its plasticity, when submitted to the action of boiling water at 150° Fahrenheit, to be its great peculiarity and most useful quality.

Gives the origin of its use as *whips* by the Malays.

Recommends it for surgical uses.

The fifth notice of Gutta Percha in Silliman's Journal, is in vol. 6, second series, p. 135, (1848.)

It says:—"The tree affording the Gutta Percha has been referred to the new gums Isonandra of Wight. Dr. Wight described two species, to which M. A. De Candolle has added two others, referred hitherto to Sideroxylon (iron wood.) W. J. Hooker calls the species affording the Gutta Percha, Isonandra Gutta.

The sixth notice of Gutta Percha in Silliman's Journal, is in vol. 6, second series, p. 246, (1848,) and is an article on Gutta Percha, particularly its chemical properties, by Edward N. Kent.

Gutta Percha is stated to be "soluble in *pure* chloroform, bi-sulphuret of carbon, rectified oils of turpentine, resin, gutta percha and tar, also in terebene, hydro-chlorate of terebene, and slightly in *pure* ether. Of these solvents the first two are the best."

The seventh notice of Gutta Percha in Silliman's Journal, is in vol. 7, second series, page 203, (1849.)

This article gives a very detailed statistical account of the collection of Gutta Percha in India and the islands.

It states that in some regions the substance is becoming scarce, and that the chief supplies must now come from Suma-

tra, the northern countries of the peninsula, and, above all, Borneo.

The total exports from Singapore are stated to have been :—

1844	. . . .	1.68	piculs.
1845	. . . .	169	"
1846	. . . .	5369	"
1847	. . . .	9296	"
1848	. . . .	6768	"
		21,598, valued at $274,190.	

The whole of this has been sent to Great Britain, with the exception of 15 piculs to Mauritius, $470\frac{68}{100}$ to the Continent of Europe, and 922 to the United States.

About 270,000 taban trees have probably been felled during the three years and a half the trade has existed.

The price of taban in Singapore gradually rose from eight to twenty-four dollars per picul, but it is now about thirteen dollars.

The Jour. Ind. Archipelago says: "In our next, we shall give some more exact details, and notice the mixtures of gutta percha, jelotong, gegrek, litchu, and other inferior guttas, the products of different trees, which are sometimes used to adulterate the taban."

ARTIFICIAL GUTTA PERCHA.

An artificial substance may be made of a mixture of Para gum-elastic and gum-shellac, which resembles that variety of caoutchouc called gutta percha so nearly, that it is very difficult to distinguish between the two, either as relates to texture or odor.

Whether any advantage will arise from the production of gutta percha in this way, either as to cost or quality, it is impossible to say. From some experiments that have been made, it appears, however, to possess more durable properties than the genuine or native gutta percha.

ARTIFICIAL ELASTIC GUM.

It is a curious fact, that some of the non-elastic gums, when combined and vulcanized, will form an artificial elastic gum fully equal in some respects, and superior in others, to Para India rubber, and nearly as elastic as it is.

The ingredients of which this substance is composed, are chiefly gutta percha and gum-shellac, in combination with other substances, submitted to the action of sulphur in the vulcanizing process. Its properties, compared with the native gum when vulcanized, are as follows: It is little less elastic, and appears to resist the sun and weather even better than vulcanized India rubber. It is peculiarly free from offensive odor, and at the present prices of gum-elastic, the artificial article is considerably the cheapest. It is not yet introduced, and, in fact, is as yet hardly known to gum-elastic manufacturers; but from present appearances it is altogether probable that this material will be found to answer, when spread upon tissues, even better than Para gum-elastic.

CHAPTER III.

INFERIOR GUMS AND RESINS.

Gum lac, or shellac. Pine and other fir-tree gums. Bitumen of various kinds—asphaltum, coaltar, &c.

It is not the intention of the author at present, to enter into a detailed history of the numerous gums and resins which, from their connection with these improvements, it is obvious might very properly be treated of in connection with the history of gum-elastic. It would be desirable, and it is the author's intention, at a future time, to give a more particular account of them, as well as minute recipes for the different proportions and mixtures, by which they are made to answer their distinct uses in perfecting the vulcanized compounds and fabrics of gum-elastic.

The term *inferior* is used chiefly for the sake of distinction. They are not, strictly speaking, inferior, except in the property of elasticity. Those of them that are known in commerce, have each their separate uses, the importance of which is well known in manufactures and the arts; they may, however, be styled inferior as relates to the inventions treated of in this work, for the reason that although the perfection of many of the fabrics and compounds depends upon some one or more of these gums, yet none of them separately will fill the place or answer the uses peculiar to gum-elastic, for the want of its elastic property, while India rubber will answer these uses when vulcanized, independent of other gums or resins, although, in some cases, it answers a better purpose in combination with than without them.

GUM LAC OR SHELLAC.

This gum, is now rapidly assuming that degree of importance in relation to the perfection of the inventions treated of in this work, that it is deemed worthy of particular notice, in connection with the history of India rubber.

The following account of it is taken from the "United States Dispensatory."

"It is a resinous substance obtained from several trees growing in the East Indies, particularly from the *Croton lacciferum*, and two species of Ficus, the F. religiosa and F. Indica. It is found in the form of a crust surrounding the twigs or extreme branches, and is generally supposed to be an exudation from the bark, owing to the puncture of an insect belonging to the genus Coccus, and denominated C. Lacca. By some it is thought to be an exudation from the bodies of the insects themselves, which collect in great numbers upon the twigs, and are imbedded in the concreted juice, through which the young insects eat a passage and escape. Several varieties are known in commerce. The most common are stick lac, seed lac, and shell lac.

"Stick lac is the resin as taken from the tree, still incrusting the small twigs around which it originally concreted. It is of a deep reddish brown color, of a shining fracture, translucent at the edges, inodorous, and of an astringent, slightly bitterish taste. Its external surface is perforated with numerous minute pores, as if made by a needle; and when broken it exhibits many oblong cells, often containing the dead insect. When chewed, it colors the saliva beautifully red; and when burnt, diffuses a strong agreeable odor. It is in great measure soluble in alcohol.

"Seed lac consists of minute irregular fragments broken from the twigs, and partially exhausted by water. It is of a light or dark brown color, inclining to red or yellow, feebly shining, almost tasteless, and capable of imparting to water less color

than the stick lac, sometimes scarcely coloring it at all. It is occasionally mixed with small fragments of the twigs.

"Shell lac is prepared by melting the stick or seed lac previously deprived of its soluble coloring matter, straining it, and pouring it upon a flat smooth surface to harden. It is in thin fragments of various sizes, from half a line to a line thick, often somewhat curved, of a lighter or darker brown color, inclining more or less to red or yellow, shining, more or less transparent, hard and brittle, inodorous and insipid; insoluble in water, but easily and almost entirely soluble in alcohol, especially with the aid of heat.

"A variety of lac is mentioned by writers in the form of cakes, called *cake* or *lump* lac (*lacca in placentis*,) but this is at present rare in commerce.

"According to John, lac consists of resin, coloring matter, a peculiar principle insoluble in alcohol, ether, or water, called *laccin*, a little wax, and various saline matters in small proportion. The resin, according to Unverderben, consists of several distinct resinous principles, differing in their solubility in alcohol and ether. The laccin is nearly or quite wanting in the shell lac, which also contains scarcely any of the coloring principle. Mr. Flachet found in stick lac 68 per cent. of resin, and 10 of coloring matter; in seed lac 88.5 per cent. of resin and 2.5 of coloring matter; in shell lac 90.9 per cent. of resin and 0.5 of coloring matter. The other constituents, according to this chemist, are wax and gluten, besides foreign matters.

"Lac, in its crude state, is slightly astringent, and was formerly used in medicine. At present it is not employed. Shell lac is wholly inert. Stick lac and seed lac are used on account of the coloring principle which they contain. Shell lac, as well as the other varieties, deprived of their coloring matter, is applied to numerous purposes in the arts. It is the chief constituent of sealing-wax. The best red sealing-wax is made by melting together, with a very gentle heat, 48 parts of shell lac, 19 of Venice turpentine, and one of balsam of Peru, and mixing with the melted mass 32 parts of finely powdered cinnabar. But

common resin is often substituted in part for the lac, and a mixture of red lead and chalk for the cinnabar, The best black sealing-wax consists of 60 parts of lac, 10 of turpentine, and 30 of levigated bone black; the best yellow sealing-sax of 60 parts of lac, 12 of turpentine, and 24 of chromate of lead, (Berzelius.) Lac is also used as a varnish, and forms an excellent cement for broken porcelain and earthenware."

The following is an interesting account of this material, taken from Ure's Dictionary.

"Stick lac is produced by the puncture of a peculiar female insect, called *coccus lacca* or *ficus*, upon the branches of several plants, as the *ficus religiosa*, the *ficus indica*, the *rhamnus jujuba*, the *croton lacciferum*, and *butea frondosa*, which grow in Siam, Assam, Pegra, Bengal, and Malabar. The twig becomes thereby incrusted with a reddish mammelated resin, having a crystaline-looking fracture.

"The female lac insect is of the size of a louse; red, round, flat, with 12 abdominal circles, a bifurcated tail, antennæ, and six claws, half the length of the body. The male is twice the above size, and has four wings; there is one of them to 5000 females. In November or December the young brood makes its escape from the eggs, lying beneath the dead body of the mother; they crawl about a little way, and fasten themselves to the bark of the shrubs. About this time the branches swarm to such a degree with this vermin, that they seem covered with a red dust; in this case they are apt to dry up, by being exhausted of their juices. Many of these insects, however, become the prey of others, or are carried off by the feet of birds to which they attach themselves, and are transplanted to other trees. They soon produce small nipple-like incrustations upon the twigs, their bodies being apparently glued, by means of transparent liquor, which goes on to the end of March, so as to form a cellular texture. At this time the animal resembles a small oval bag without life, of the size of a cochineal. At the commencement, a beautiful red liquor only is perceived, afterwards eggs

make their appearance, and in October or November, when the red liquor gets exhausted, 20 or 30 young ones bore a hole through the back of their mother, and come forth. The empty cells remain upon the branches. These are composed of the milky juice of the plant, which serves as nourishment to the insects, and which is afterwards transformed or elaborated into the red coloring matter which is found mixed with the resin, but in greater quantities in the bodies of the insects, in their eggs, and still more copiously in the red liquor secreted for feeding the young. After the brood escapes, the cells contain much less coloring matter. On this account the branches should be broken off before this happens, and dried in the sun. In the East Indies this operation is performed twice in the year; the first time in March, the second in October. The twigs incrusted with the radiated cellular substance, constitute the stick lac of commerce. It is of a red color, more or less deep, nearly transparent, and hard, with a brilliant conchoidal fracture. The stick lac of Siam is the best; a piece of it, presented to me by Mr. Rennie, of Fenchurch street, having an incrustation fully one quarter of an inch thick all round the twig. The stick lac of Assam ranks next; and last, that of Bengal, in which the resinous coat is scanty, thin, and irregular. According to the analysis of Dr. John, stick lac consists of

An odorous common resin	80.00
A resin insoluble in ether	20.00
Coloring matter, analogous to that of cochineal	4.50
Bitter balsamic matter	3.00
Dun yellow extract	0.50
Acid of the stick lac (laccic acid)	0.75
Fatty matter, like wax	3.00
Skin of the insects and coloring matter	2.50
Salts	1.25
Earths	0.75
Loss	4.75
	120.00

"According to Franke, the constituents of stick lac are, resin, 65.7; substance of the lac, 28.3; coloring matter, 0.6.

"Seed lac. When the resinous concretion is taken off the twigs, coarsely pounded and triturated with water in a mortar, the greater part of the coloring matter is dissolved, and the granular portion which remains, being dried in the sun, constitutes seed lac. It contains, of course, less coloring matter than the stick lac, and is much less soluble. John found in 100 parts of it, resin, 66.7; wax, 1.7; matter of the lac, 16.7; bitter balsamic matter, 2.5; coloring matter, 3.9; dun yellow extract, 0.4; envelopes of insects, 2.1; laccic acid, 0.0; salts of potash and lime, 1.0; earths, 6.6; loss, 4.2.

"In India, the seed lac is put into oblong bags of cotton cloth, which are held over a charcoal fire by a man at each end, and as soon as it begins to melt, the bag is twisted so as to strain the liquified resin through its substance, and to make it drop upon some smooth stems of the banyan tree, (Musa paridisa.) In this way the resin spreads into thin plates, and constitutes the substance known in commerce by the name of shellac.

"The Pegu stick lac, being very dark colored, furnishes a shellac of a corresponding deep hue, and, therefore, of inferior value. The palest and finest shellac is brought from the Northern Circas. It contains very little coloring matter. A stick lac of an intermediate quality is brought from the Mysore country, which yields a brilliant lac-dye and a good shellac.

It is but recently that gum-shellac has been used in the manufacture of the vulcanized compounds. Thus far it appears to be indispensable in one of the hard compounds, and in many of the fabrics, it is preferable to all other inferior gums and resins, on account of the more agreeable odor of the fabrics. In these it is mixed in about the proportion of one part shellac to three parts caoutchouc.

PINE AND OTHER FIR-TREE GUMS.—TURPENTINE, &c

The abundance and commonness of these substances in northern climates render it quite unnecessary to treat of their production and native qualities. The importance of their use, particularly that of pitch and resin, in combination with caoutchouc, when submitted to the process of vulcanization, is only now beginning to be known.

They have, together with coal-tar, asphaltum, &c., in some cases been used in small quantities by both American and English manufacturers of gum-elastic. The sudden temporary advance of caoutchouc to a very high price, in 1851, has induced the writer, as well as the manufacturers of caoutchouc, to attempt their use with that of coal-tar in larger quantity; and it has been found that some of them, if not all, when properly treated, may be used with great advantage in some of the vulcanized compounds in equal proportions with caoutchouc.

BITUMEN OF VARIOUS KINDS.—ASPHALTUM, COAL-TAR, &c.

Considering the vegetable origin of these substances, it would be reasonable to suppose they would be found to combine readily with caoutchouc, and also be susceptible of vulcanization when combined with it. This has proved to be the fact with regard to them. They are also found valuable, not only on account of their abundance and cheapness, but also because they serve to give a polish or lustre to the articles when it is desired, and likewise to prevent the effervescence of an excess of sulphur in the fabrics.

They are cheaper substances than any of the vegetable gums, as they are now obtained.

Some of them, particularly coal-tar, was used at an early day to a limited extent in the manufacture of caoutchouc. The same causes which operated to bring about the more extensive use of the resinous gums in this manufacture, have also led to the use of bitumen and coal-tar in greater quantities in the vulcanized compounds. The chief objection to their use is, that they impart their peculiar odor to the fabrics ; but in some of them which are used in the open air, where this odor is less objectionable, bitumen or coal-tar may be used in equal proportions with caoutchouc or India rubber.

CHAPTER IV.

EARLY HISTORY OF GUM-ELASTIC.

Condamine's paper to the French Academy on gum-elastic. First importation of shoes into the United States. Para the principal place of export. Method of gathering the gum by the Indians, and their manufacture of shoes and toys. European manufacture. Of McIntosh. Of the French. American manufacture. The Roxbury Company.

"Gum-elastic was first introduced into Europe and the civilized world from South America, about the close of the seventeenth or the beginning of the eighteenth century.

It is certain that very little attention was paid to the new material until the year 1736, when, as we are informed, M. de la Condamine, a French Academician at Cayenne, presented a paper to the French Academy, describing the tree from which it is obtained, and the mode of preparation practiced by the natives of South America.

Very little was heard of it until 1790, when some pieces of it were brought to England from India. It was then found to possess one of its peculiar properties, adhesiveness, which renders it valuable, for erasing pencil marks ; for this and its wonderful elastic property, there has never been found any substitute.

The use of the article for other purposes, was first learned from the Omagua tribe of Brazilian Indians, who cured it in their peculiar manner, as described under the head of 'Indian Manufactures.' By these Indians it was brought to the notice of the first Portuguese settlers in Para, and by them the traffic in it was commenced with Europeans and Americans.

The first pair of shoes imported was brought into the United States in 1820. They were gilded, and had long pointed toes, like those of the Mandarin of China. They were said to be

from India, but as no shoes have been brought from that country since, the origin of this pair is doubtful. In 1823, a lot of five hundred pairs was brought into Boston, and sold at high prices, they were soon after imported in large quantities. From that year may be dated the commerce in this article, which has since grown to such extent. The India rubber bottles were imported into Europe and the United States in small quantities, many years before, and were commonly cut up and used for the purpose of erasing pencil marks."

INDIAN MANUFACTURE.

"The city of 'Santa Maria de Belem do Grand Para,' is situated on the southern branch of the river Amazon, called the Tocantins, one hundred miles from its mouth, and lies in 1½ degrees S. latitude. Para is the capital of the truly magnificent province of the same name, which forms the northern boundary of Brazil; the city contains twenty thousand inhabitants, and being the only port of entry on the Amazon, is a place of considerable commercial importance, receiving, as it does, all the produce of that immense river, on which are situated a great number of important trading villages.

There are several American, English, and French houses established here, but the principal part of business is carried on by Portuguese merchants."

We are not informed by what steps the natives advanced to the degree of perfection attained by them in the manufacture of this singular substance. That the natives should have invented their various processes of gathering, moulding, and smoking the native gum, is certainly creditable to their ingenuity. It is only recently that civilized men have been able, by the aid of chemical combinations, to improve upon the qualities of the substance which the Indians imparted to it by their mode of manufacture.

The plate 1 represents an Indian camp in the vicinity of Para, where the gum is manufactured, from which place most of the gum has heretofore been exported to the United States.

No. 1, in the cut,	.	Indian tapping the tree.
" 2 "	.	Attaching the clay pipes.
" 3 "	.	Pouring the gum upon lasts or clay forms.
" 4 "	.	Smoking the shoes or bottles.

The two words, Indian-rubber and India-rubber, are indifferently applied to caoutchouc or gum-elastic: both of these terms are alike correct; and the first, as relates to the Indian of Brazil and his manufacture; the latter, as applied to the article coming also from India.

The articles of native gum heretofore imported from Para, as shoes, bottles, and toys, have always been exclusively made by these Indians. In this manufacture, the ingenuity of the savage may excite our admiration, especially if we take for granted, as in the absence of other information to the contrary we are authorized to do, that he is the inventor of the moulding and smoking process. This art is practiced by the natives, a tribe of Omagua, and is unknown in any other part of the globe. The shoes of their manufacture have been imported into the United States since 1820, and the bottles since 1800. These were first cut in pieces, and used for rubbing out pencil marks, and it is from this apparently trivial application that the substance took the name of rubber. The average export of Para shoes to the United States since 1820, has amounted to about five hundred thousand pairs per annum; and the export of India rubber from Para in the form of shoes, will no doubt continue for a long time to come. For it always happens that when articles of great utility once obtain in the market, a long time must elapse before their consumption ceases, however great the subsequent improvements in these articles, or their substitutes may be.

The Indian manufacture of the gum is conducted on a small

scale by individuals in the neighborhood of the city of Para, and is carried on more extensively at a greater distance, within a circuit of about fifty miles.

The gum is obtained from the tree on the slightest incision, at all seasons of the year; but it flows most freely, and the gum is most easily collected, during the dry season; very little, comparatively, is collected during the rainy months. The business is most attended to during the months of May, June, July, and August. The gum gathered at this time is considered the best. Camps or orchards are selected where the trees are most abundant, which is commonly in swampy or low grounds.

"The method of collecting and manufacturing the gum, is as follows: The trees are tapped early in the morning, by a blow of a hatchet, about an inch in width, and a clay cup, resembling the mud swallow's nest, made by the hands of the workmen, is attached to the tree immediately under the incision. *One person*, with his hatchet, takes his beat, of a mile, perhaps, in extent, taps his seventy or eighty trees, which are as many as an active fellow can attend to, commencing at five and finishing at seven o'clock in the morning. The sun, be it understood, always rising at six o'clock. Having now tapped his number of trees, and attached about six cups to each of them, he returns to his starting place, and with his calabash goes the same round, and collects the *small table spoonful* of milk, or sap, which he finds in *each* clay cup. As the man goes his circuit, he empties the sap into his calabash. The cups are fitted into each other, and covered with leaves at the foot of each tree to keep them moist, for the next tapping of the same tree in another place. In this manner he has obtained from one to two gallons, according to the season or other circumstances. The milk by this time has ceased to flow, and the incision through the bark already becomes clogged.

The milk, after being collected, is taken home, where immediate preparations are made for the smoking process, which must all be finished before two o'clock, otherwise the milk will coagulate and be lost. This service of manufacturing the gum into

shapes is usually performed by the man's wife or daughters, by pouring the sap upon clay forms or wooden lasts, which are held in the hand. It takes from twenty to twenty-five coats of the sap to form a shoe. Upon applying each successive coat of the gum in this way, the article is held over the small furnace represented by fig. *in the plate, and smoked for* about *half a minute.* The smoke is produced from the burning of the wassou palm-nut, which is plentiful in that country; it is about the size of the largest hickory nut, but resembles more the black walnut. It is stated, no doubt correctly, that no other smoke will produce the same effect upon the gum. The natural color of the native gum is yellowish white; the dark brown color of the imported article is imparted by the smoke. The gum is considerably hardened by this process; it is also rendered less adhesive, and is so far changed as to be much improved for the subsequent purposes of re-manufacturing, as formerly conducted in the United States and in Europe. This effect is not needed for the manufacture by my process.

The shoes and toys, when sufficiently dried in this manner, are often ornamented in a rude way, by impressions made by the point of a knife or a wooden stamp, about twenty-four hours after the articles are finished."*

After four or five days, the clay is washed out of the article formed, or where lasts are used they are removed from the shoes; which are next tied together in pairs, and hung on poles. In this manner they are conveyed to Para, where they are purchased by the merchants for exportation, and stuffed with hay or grass for the purpose of keeping them in form. It is some months before the shoes become hard enough for service; but they are gradually hardened by age. The shape of the shoes has commonly been improved by lasting and trimming, after their importation into the United States. The firm of Messrs. Smith & Son, the first dealers in these shoes in New York, obtained a high reputation for their shoes, by taking advantage of the above circumstance, and keeping their stock on hand until well

* Charles Smith, Esq.

seasoned. Much less care is taken by the natives in preparing the bottles, which are made for the supply of the foreign remanufacture; this is productive of much mischief, as is fully stated under the head of "Method of gathering the gum."

The trees are not tapped oftener than every other day, and when suffered to remain undisturbed for several days, the yield is proportionally greater. These trees continue to yield sap for upwards of twenty years; and it is a well known fact, that the oldest and most frequently tapped trees produce the richest sap.

Following is a more detailed description of the method pursued by the Indians near Para in gathering the gum and manufacturing shoes; written by an individual who formerly resided in Para.*

The India Rubber Tree—Mode of collecting the Gum, and of making and figuring India Rubber Shoes.

In reply to your inquiries respecting the India rubber business at Para, I will endeavor to say something of what I lately saw there as to the mode of preparing the article for market. The "Seringa" tree, as it is called by the natives, (the India Rubber,) is common to the whole valley of the Amazon, but is most abundant on the island and low lands, which at times are inundated in the rainy season. The trees are scattered promiscuously through the forest, and reach a diameter of eighteen inches or more; the bark is smooth, somewhat resembling the beech, but thicker. The leaf is an oblong oval, thick and glossy, the wood white and rather soft, being useless for building, as it decays very soon. The milk is white and tasteless, and may be taken into the stomach with impunity, much resembling the milk which exudes from the milk-weed of New England, and seems to reside in the bark, or between the bark and wood. The first work of the "Seringeros" (as the Indians who gather the article are called,) is to open foot-paths from tree to tree in the forest, so as to form a circuit sufficient for the operations of one man; so that each man has his circuit

* Mr. W. D. Gookin, Southport, Conn.

diverging from the cabin. These paths constitute the chief value of a location, rather than the soil, and are sold or rented to the occupants at moderate prices. The Seringeros generally locate as near the town as possible, that their supplies and market may be at hand; for they depend upon the rubber for subsistence. The hut, or cabin, is built upon some branch of the river, or on some of the numerous tide creeks which penetrate the whole of this flat country near the river. The cabin is built on posts set in the ground, with the floor elevated from two to four feet, so as to be above the inundations and spring tides. It is thatched with some kind of palm-leaf, and the rind of the same tree furnishes the boards for the floor. They live simply and cheaply; for a basket of farina, a coarse quality of tapioca, made from the mandicoa root, and costing from 50 to 150 cents, sustains a person some thirty-five days, and is eaten dry, or a little moistened, with the addition of a piece of dried fish roasted. This, with coffee, is the standing food of the country people, Indians, and negroes, who are the collectors of rubber.

The tree requires to be tapped every day, by making an incision into the bark with a species of tomahawk, about an inch wide. Beneath each incision is attached a cup made of moist clay, about the size and form of the half of a goose egg, which keep their places by the adhesion of the clay. From six to ten cups are placed upon a tree, which yield from two to five tablespoonsful of milk each, per day. The trees are tapped from the root to as far up as can be reached even by a scaffold. Each incision makes a rough wound on the tree, which in time, though not dead, makes them useless, because a smooth place is required on which to attach the cups.

The men start out at daylight to tap their trees, each taking a ball of kneaded clay in his hand for making any cups that may be wanted, and having made their circuit in three or four hours, return to the house for breakfast. Soon after noon, they make the round again, to collect the milk in gourds, slung in thongs of bark, and hung over the shoulder. The cups are detached from the tree to empty them, and remain covered up at

the foot of each tree for the next day's use. On reaching the house, the milk is manufactured at once into shoes, bottles, or sheets, as it soon hardens. This is often done by females. A fire is made of some nuts, common in the forest, over which is placed, inverted, an earthen pot with a hole in the bottom, whence issues a jet of hot smoke. The wooden last, after being smeared with clay to prevent adhesion, is dipped into the milk, which adheres to it like paint, and is hardened by one or two seconds' exposure to the hot smoke, then is plunged again successively into the milk until the required thickness is obtained. Extra coats are given to the heel and sole. About sixteen to eighteen dips form the shoe—say ten general coats and six extra for the bottoms and heels. Each last has a handle which is stuck into the ground for the shoe to dry. When finished, they are of a dingy white ; but by exposure to the sun and dew, in a few days turn brown and black, during which they are covered with drops of water exuding from the rubber. In two days the shoes are hard enough for figuring, which state lasts some three days. This is done simply by drawing lines on the soft surface with the rounded points of wire or needles, two or three of which are fixed in a handle, forming a species of style, with which figures are formed according to fancy. Stamps do not answer, perhaps owing to the irregularity of the surface of the last. In a week the shoes are taken from the last (which once were made of clay, but now wood is only used.) As soon as a few pairs are finished, they are taken to market and sold by the makers, under previous engagements, and perhaps for advances received, at from ten to fifteen cents per pair. One man collects milk for six to ten pairs per day. The dipping of a pair of shoes occupies about fifteen minutes, and the figuring, the same or less.

The bottles are made by dipping a ball of clay formed around the end of a stick, which is removed when dry or by soaking in water; these, with sheets and refused shoes, are consumed in the manufacture of metallic rubber, and are generally shipped in bags or bulk, while the shoes, after being stuffed with straw

to preserve the form, are packed in boxes for shipment. The rubber and shoes pay a provincial duty of fifteen per cent., at which time both duties are exacted, unless the certificates of the payment of the city duty are produced. The rubber of Para is the best known, and thus far has only been collected near the coast; but the "Seringa" abounds throughout the banks of the Amazon and its numerous branches, up to the foot of the Andes, as well as also the Orinoco, and other parts of South America: hence the supply will ever be inexhaustible. The collection is mainly confined to the dry season, from the effect of the rain on the crops.

EUROPEAN MANUFACTURE.

With the European manufacture the author is less acquainted than with the American. It is generally well known that the manufacture of gum-elastic in the civilized world was first commenced in Europe, and that of the India rubber cloths in particular, in England. The manufacture of the raw gum into threads, weaving it, &c., has been the subject of many patents and much litigation, both in England and France; notwithstanding which the manufacture has always been a successful one. In those countries, however, a very different class of articles was made, from those which were subsequently manufactured in the United States. The manufactures of these countries consisted mostly of articles made from the raw material smoked by the Indians, such as woven suspenders made of braided cloth, &c., in which the gum, not being dissolved in their manufacture, and also being protected by a covering of thread by weaving or braiding, it was not so immediately liable to decomposition and loss of its elasticity, as it was in the case of the re-manufacture afterwards carried on in the United States, in other articles in which a solvent was used.

The Macintosh goods, in which a solvent was used, were less liable to damage and decomposition, because the gum was protected by being spread between two cloths. At that period, the

Europeans had more experience, and understood the manufacture of gum-elastic better than the Americans, and did not, like them, fail in their first attempts.

In the year 1821, Charles Macintosh, Esq., established the manufacture of the well-known and long-celebrated Macintosh goods. For the information of those who may chance to be unacquainted with these goods and the method of their manufacture, it may be said they consisted chiefly of wearing apparel, such as coats and capes, and what is generally termed air-work, such as beds, pillows, cushions, life-preservers, &c. The method of manufacture consisted in spreading a coat of dissolved gum between two cloths, which rendered them water-proof. The adoption of this method is itself proof of the perishable nature of the gum, and the imperfection of the goods previous to the introduction of the improvements treated of in this work. As the method, in fact, amounts to protecting the gum between two cloths, in order to make its water-proof qualities available, instead of protecting one cloth by either one or two coats of gum on the outside, as is done with the heated or vulcanized article; and, although thus protected in the Macintosh fabric, the gum is found to melt and penetrate through the meshes of the cloth in a warm climate, or when much worn by those who perspire freely. In the humid atmosphere of England, and in other cold countries, notwithstanding their imperfections, these goods have been found extremely useful; and the inventor not only attained a high reputation, but was thereby enabled to accumulate a very handsome fortune.

About the year , the manufacture of gum-elastic was commenced in France, which consisted almost wholly in pressing the Indian bottles into flat pieces, and afterwards cutting them by machinery into thread, which were wound or braided over with silk, and next woven into suspenders, or sold for guard-chains or other similar purposes. This thread was also used as a warp, and woven into suspenders without covering. The manufacture has been a successful and profitable one, and has been carried on to a very great extent to this time; for although the elasticity of the article is lost by use, it continues long

enough to give satisfaction to the wearer, in the absence of anything better.

The well known house of Messrs. Rattier and Guibal, Paris, have been most extensively engaged in the manufacture, and have brought it to a high state of perfection, producing a variety of useful and beautiful articles. They have continued their manufacture to the present time, and are now interested as licensees in the recent improvements of the author.

AMERICAN MANUFACTURE.

Various experiments were made in the United States with the solution of gum-elastic, as early as 1824. It had long been known to chemists, that the essential oils were solvents of the gum, before attempts were made by manufacturers to manufacture it, or restore it to its native state, after having been dissolved. The secret, as it was for a long time called, of dissolving, became at length generally known as early as 1829.

From this time, great numbers of persons turned their attention to experimenting with it, and the subject became one of general interest. Mr. S. C. Smith, of Providence, Rhode Island, one of the first who commenced the manufacture, opened a store in 18—, for the sale of India rubber goods, at the corner of Maiden lane and William street, N. York. In 18—, this firm, subsequently S. C. Smith & Sons, removed to Chatham street, where they carried on a prosperous business in the manufacture of shoes, from the sheets of gum made by the Indians at Para, and in the sale of the Para shoes. The shoes of this house attained a high reputation, by their keeping a large stock on hand, and allowing them to become well seasoned before they were sold. Messrs. Smith & Son retired from the business with a handsome fortune, shortly after the recent improvements were introduced.

Among the first to manufacture India rubber, were Mr. John

Haskins and Mr. Edwin M. Chaffee, of Roxbury, Massachusetts, who commenced their operations in 1832. By these gentlemen, in connection with some others, of Roxbury and Boston, the celebrated Roxbury India Rubber Company was started, which was shortly after incorporated, with a capital of $300,000, which was afterwards increased to $400,000. For this company Mr. Chaffee invented the famous machine for spreading gum-elastic without a solvent, which is now so generally known as the mammoth machine; machinery of this kind, but of smaller dimensions, is now generally used in the United States, in the manufacturing of gum-elastic. The mammoth machine weighed about thirty tons, and was patented by Mr. Chaffee, who disposed of the patent to the Roxbury company for the sum of $10,000; the machine itself cost nearly $30,000, owing to its uncommon size and the length of time in building.

Immediately after the establishment of the Roxbury company, many other companies were incorporated, with the impetuosity and daring so characteristic of American enterprise. In Boston, South Boston, Chelsea, Woburn, and Framingham, Massachusetts; New York, Staten Island, and Troy, New York; factories were started with capitals of from $50,000 to $500,000. After striving from one to three years to surmount the difficulties of the manufacture, they, as well as many individuals who had engaged in the manufacture, abandoned the business as hastily as they entered it, with generally a total loss of the capitals invested. As I shall have occasion to speak again, (in connection with my own experiments,) of the causes of the disasters which impelled them to abandon the manufacture, and induced me to experiment for the purpose of overcoming the difficulties, which have been previously referred to, I shall not enlarge upon them here.

CHAPTER V.

METHOD OF GATHERING THE NATIVE GUM.

The present method of gathering Gum-elastic objectionable. The smoking process unnecessary. Exposure to the sun injurious. Disadvantage of impure admixtures in gathering to manufacture. Virgin gum. Imported impure gums. The tropical regions yield an immense supply of Gum-elastic.

THE object of this chapter is not to describe the method of gathering the gum as it is now practiced. This method is described under the head of "Indian Manufacture." My purpose is briefly to draw the attention of the mercantile community to the subject, and to satisfy them that the present is perhaps the worst possible method that could be devised, and that it is attended with a vast amount of labor which does no good, but a great deal of injury.

The market is now supplied almost wholly by the importation of India rubber from Para, which has been subjected to the process of Indian manufacture. This was in former times useful, but is now wholly unnecessary. What renders this article still more objectionable, is the careless manner in which the Indians perform their work, probably from ignorance of its importance; and in some instances, it would appear that foreign substances are purposely intermixed, in order to increase the weight of the gum.

The writer does not profess to be sufficiently informed to prescribe any precise mode of gathering and treating the native gum, instead of that at present practiced in Para. The most suitable way will suggest itself to any man of intelligence, who is informed in what state the gum is wanted for the manufactories. Since the manufacture has undergone the changes

treated of in this work, that which needs to be most insisted on is, that the gum should not be smoked, and should be kept clear from intermixture with any foreign substances. The state of the gum in other respects, and the size and shape of the masses, are of little consequence. Owing to the difference between the trees of India, and those of South America, and to the difference in the flowing of the sap, and other circumstances, different ways may answer best in different countries, taking into consideration the mode of transportation, and always bearing in mind that the gum should not be long exposed to a hot sun. If it is drawn upon hides, or into ceroons made of hides, they should not be greasy, for although grease may be mixed with the gum in the process of vulcanizing, without harm, and sometimes even with advantage, this cannot be done with the native unvulcanized gum without destroying it.

The writer worked different lots of gum, collected in ceroons and casks, and also on hides, as early as 1835. These parcels of gum were of the very best quality, although they were in a filthy state, and for this reason, had been suffered to remain in the hands of the importer for years; and also, for the reason that at the time it was imported, there was little or no sale for gum of any description, unless it had been smoked by the natives, and submitted to the Indian process of curing with the wasson palm-nut, which was then necessary, in order to render it fit for the use of the American or European manufacturer. The shippers of these parcels, probably did not know the reason why the article was undesirable; and probably do not now know, that the same article would now bring the very highest price, if clean, notwithstanding the offensive odor, which is usually consequent upon the gum being collected in these ways, and being left to coagulate in the whey. When drawn into ceroons, the whey discolors the gum, and when dried in it, becomes hard, and has the appearance of loam; but this is softened and washed out with hot water, and the unnatural, tainted odor, is dispelled in the process of manufacture.

Possibly it may be best obtained by tapping the roots of the trees, which it is inferred may be done from the spontaneous flowing of the virgin gum from the trees which are not tapped. In countries where it is obtained by allowing the sap to flow down the side of the tree, the loose bark should be scraped from the tree. When the trees are abundant, and the branches are easily accessible, (as is said to be the case with some species of the tree,) the branches may be chopped off, and the gum drawn on hides, or into ceroons, or sacks made of hides.

As the gum is not injured by salt water, it requires no protection from it, and when it is most convenient, may as well be imported in ballast, as in any other way. It is sometimes imported thus from India. There is no danger of loss any where, under any circumstances, from spontaneous decomposition. In this respect, gum elastic is imperishable in its nature, and not subject to decay, like some other vegetable substances.

To conclude this important part of the subject, I repeat that it is only necessary to guard against two things, namely, the intermixing of foreign substances with the gum, and exposure to the sun. When it has been exposed to the sun for a long time, that part which is damaged may always be known by its melted and soft state, and where the masses are larger, as those from India sometimes are of a ton weight or more, the effect of the sun, or weather, will not extend so far beneath the surface as to cause much loss in the article, even if exposed a long time.

The demand for native gum-elastic is becoming so great, and increasing with such rapidity, that there is no occasion for the Indian to delay the supply, by stopping to smoke it in layers of one hundred in number, to the thickness of an inch, when they may have enough to do to gather it with the least possible trouble. Virgin gum, that which is found at the root of trees which are not tapped, is always of the very best quality. I would here remark that it will be important to the interests of the countries, where the gum is gathered, as well as for those engaged in its importation, to notice particularly the following facts. In the early attempts to manufacture the gum in the

United States, it was found that no kind, except that which had been cured (in the manner alluded to) by the Indians, could be manufactured in any way, into goods that would not, in a very short time, decompose. This fact being generally made known in Para, and being exactly adapted to the state of the manufacture there, the Indians continued to smoke it, and the exporters have continued to send this kind of gum, and the manufacturers are now compelled to work it because they can obtain no other. This unfortunate state of things exists for the reason that it is not generally known that for the present manufacture, by the vulcanizing process, the gum is very much injured instead of being improved by the present mode of gathering, and curing it by this tedious and expensive process of smoking. But the greatest objection to this method is, that being drawn into the clay cups, and moulded on clay, the clay gets mixed with the gum, and also during the process of smoking in the air, insects, and other foreign substances become mixed with it; beside, it is so much discolored by the smoke, that it cannot be worked into bright colors, or made so white as would be desirable for the purpose of printing.

Were the gum drawn into close vessels, or into pans, and thus kept quite clean without this waste of labor, it would not only cost less, but be more than doubly valuable, for many uses, especially for the manufacture of air-proof fabrics, which could be made air-tight, with much less than half the thickness and quantity of gum that is now required, because when the gum is perfectly clean, articles of air work may be made air-tight, with an exceeding thin layer of gum, while a very small particle of dust in the gum will cause a leak, in a sheet thicker than would be required for this purpose, if it were quite pure.

Although the labor of smoking is performed by Indian females, and may not be considered of much value, it is nevertheless a waste, the results of which are only evil, requiring the more costly labor of others to undo them.

The importance of a change in the mode of gathering the gum, will fully appear, when it is considered that the chief cost

in the manufacture, by the vulcanizing process, consists in cleaning and crushing the gum, or in other words, in undoing that which need not have been done.

On the Pacific coast of South America, the gum is said to be much more abundant, and more easily obtained than in Brazil. The gum which flows spontaneously from the roots of trees that are not tapped, and which is known and has been described, as virgin gum, and which is obtained in masses of from five to thirty pounds, although by no means clean, is decidedly better than that which is smoked. Unfortunately, the present mode of gathering gum, has become too general in Para to be suddenly changed. Another circumstance which tends to retard the change proposed, is the fact that from 1833 to 1835, when speculation raged in gum-elastic in the United States, large quantities of the virgin gum, and also of the gum from the Pacific coast, were sent out to the United States. It was such as is now wanted, and was gathered in the manner already described, by drawing it upon raw hides and into ceroons, but it could not be used, as the manufacture was then conducted. The gum thus exported to the United States remained a long time unsold; therefore, the change in the manufacture, as well as in the market, must become known, before a change can be expected in the mode of collecting it, or rather before the proper methods which were prematurely adopted, and subsequently checked, will be recommenced. From 1830 to 1835, many large shipments arrived from India, of from twenty thousand, to one hundred thousand pounds weight, evidently gathered where it flowed down the sides of the tree, and was stripped off with a mixture of bark. Other parcels of from five thousand, to ten thousand pounds, were brought from Valparaiso in large heavy sheets drawn from the tree upon raw hides, and having the appearance of hides rolled up. Others arrived in ceroons, or bags made of hides. This last article, although in a filthy state, on account of the gum being coagulated in a spongy mass, and the whey being turned to a dark brown color, and dried upon it, became quite clean when washed, and, in fact, was of the best

quality. All these kinds remained complete drugs in the market, until they were re-shipped to England or elsewhere, or gradually found their way into varnishes, boot-blacking, &c., at very low prices. Were the merchants of India to try the experiment of shipping the India gum free from bark, and those of Valparaiso, South America, to send it in the same way they formerly did, but cleaner if possible, they would no doubt receive a very different account of sales. Fresh cargoes of India gum are at this time arriving, which meet a ready market, but they continue as yet to be mixed with the bark of the tree.

As gum-elastic is a production of most, if not of all tropical regions on the globe, and as the supply is, beyond question, inexhaustible and abundant for all its various uses, when the numerous facts become generally known with regard to its importance as an article of commerce, it may be hoped that as new channels of supply are opened, the best modes will be adopted of collecting it; and that the Indian tribes of Para will become reconciled to relinquish the manufacture to their more civilized competitors, and find a more profitable employment by sending them the native gum in its unmanufactured and pure state.

The certainty that there will in future be a very great consumption of the various kinds of India rubber and water-proof gums, has caused a good deal of apprehension with many as to the supply, and it is asked, Where is it to come from?—will there not be a scarcity? It is true that, owing to the sudden and rapid extension of the manufacture, together with some commercial speculation in the article, the price has for the present year, 1851, been unusually high; but this is a state of things which will not continue. The supply is literally inexhaustible. There is a belt of forest trees, extending ten degrees each side the equator around the globe, which yield these gums of various kinds; and, as has been the case with turpentine and resin, the greater the demand, the cheaper in all probability these substances will be, when once the attention of mankind is turned to the subject, and (that which is already being done)

enterprising civilized races engage in the business of collecting it, instead of relying on one tribe of Indians on a single river, there will no longer be any solicitude on the score of supply.

There is greater danger, in the lapse of time, of a scarcity of pine trees. It is matter of history that, in the early settlement of America, such fears were entertained, and laws were passed in some of the colonies to prohibit the cutting down of pine trees. The alarm then was, that there would not be a supply of masts, turpentine, tar, &c., for the royal navy. The clearing of lands for cultivation, the enormous destruction for fuel, ship and building materials, make great inroads upon the pine forests; but these causes are not, and are not likely to be, in operation for the extinction of the India rubber tree, with the exception of one variety, that of the Gutta Percha, which it is said is cut down for the purpose of obtaining its gum. Whether this waste is at all necessary, or whether it will continue, is unknown to the writer.

Since it has been found that common resin, gum-shellac, and coal-tar, can be vulcanized in proportions of equal parts with India rubber, great as the demand must unquestionably become for the fabrics made of these substances, there is no probability of a scarcity of the raw materials.

CHAPTER VI.

CLAIMS OF THE AUTHOR AS INVENTOR.

Sheet India rubber. Peculiarities of the invention. Laminated fabrics of cotton and gum. Commencement of the manufacture. The author's reasons for patenting his improvements. The process of solarization. An extract from Percival. Awards given to the Inventor. Certificates. Copy of original specification of patent, 1844, as legally prepared in 1841. The process patented in England, in 1844. Synoptical statement on the author's claim to his inventions.

It is not the design of the author to discuss, in this chapter, claims of a legal nature, or the merits of minor inventions which have been made by him during the course of his experiments. Such of the inventions as are exclusively his, both as relates to their origin and their development, as also those that are patented by him, are indicated by his initials affixed to them in the index. Pains have also been taken by him to credit to other persons the inventions which originated with them, even though they have been developed and brought to the notice of the public by the writer.

The points to which it is desired to draw particular attention in this chapter, are the three following:

1st. The manufacture of gum-elastic into sheets, in 1835, and the discovery of the nitric acid gas process in 1836. 2d. The discovery of the heating or vulcanizing process in 1839. 3d. The important invention of the fibrous fabrics in 1840, perfected in 1850? The invention of the inodorous fabrics is here claimed, although its peculiar merit has not been tested by the public. These are matters of history, of which all who are informed on the subject, in the United States, have knowledge.

That India rubber could be manufactured into sheets in such a manner as to prevent the surfaces, when brought in contact, from adhering together, and the whole becoming a solid mass, was never known until 1835, or that it could be made effectu-

ally, dry, with a cloth-like surface, before 1836. This discovery was the subject of much comment by the press throughout the United States, from 1836 to 1838; and in reference to it the certificates were given, and medals of public institutions were awarded at that period, with the inscriptions, which will be found in the appendix. They are only selections among many testimonials of a similar authority.

But what is of greater importance, is the fact that before the year 1839, it was never heard of that India rubber of any kind could be so prepared or wrought,—whether by the Indians, or from the gum as it exudes from the tree, as was attempted by Americans, or *re-manufactured* by any process whatever,—that it would not be stiffened by the cold, or softened by exposure to heat of the sun and a warm climate, and also that it would not be quickly acted upon by all the essential and common oils, or be divested of its peculiar property, adhesiveness, which is now done in the manner hereafter described.

This change wrought in gum-elastic by sulphurous gas and a high degree of heat, was first made by the writer in the town of Woburn, about ten miles from the city of Boston, Mass., in the winter of 1838 and 1839, under circumstances of such a nature, that there could be no mistaking the facts in the case, or blending the results of the writer's labors with those of any other individual. The circumstances of the inventor prevented public notoriety of the discovery of 1839 as soon after it was made as would have been desirable. These circumstances are alluded to in a subsequent chapter.

A more detailed account of the particulars attending this discovery, is given under the head of experiments.

At the time specified, the inventor was so completely insulated by misfortune, (seemingly courted by him, in persisting in what appeared to every one else an idle and foolish enthusiasm,) and all his acts and pretensions at that time were so censured or ridiculed, as to identify, in the most unquestionable manner, the inventor with the discovery. As regards the original state of native India rubber, and the change wrought in it by treat-

ment with sulphur and heat, and the importance of that change, there need be no more said in this place. The statements made in other parts of this work, relating to the substance both in its native state and after it is vulcanized, may at any time be tested and demonstrated, by the employment of chemical agents.

As to the third claim specified, which relates to the fibrous fabrics, it needs to be distinctly understood that this claim is made for laminated fibrous fabrics, and not for the mixing of fibrous substances with gum-elastic by grinding. For a process of mixing fibres by grinding, a patent has been issued in the United States, to my brother, Nelson Goodyear.

In 1844, the writer obtained a patent in the United States, for a method of manufacturing raw cotton and wool, when laminated with alternate layers of gum-elastic; but notwithstanding five years have elapsed, he did not succeed in demonstrating the practicability of the invention, even to his own satisfaction, until 1848. It is now rendered practicable only by important modifications of the original method of operating. Neither is there an unqualified claim made to the first idea of combining fibrous substances with gum-elastic. The mixing of fibrous substances with gum-elastic has been discussed since the commencement of the manufacture; but to the development and practical demonstration of that which had existed only as a vague and undefined theory, the author makes unqualified claim. One argument in reference to the invention of the laminated fabrics, and the different articles made of them, should be conclusive in all future time, as to whom these inventions rightfully belong. It is this: although the number and quality of specimens of these inventions are amply sufficient to demonstrate their utility, they are, at the present time of writing, 1851, so new, that the writer is nearly alone in his estimation of their value; and his judgment is not only doubted by the public, but even by his associates and licensees, as to the importance of these inventions. He is, however, equally confident of their great value, in a mechanical or constructive sense, as of the value of the vulcanizing process in a chemical point of view.

The same remarks, so far as relates to invention, are applicable to some other fabrics and articles which are entirely new, the claim to which is designated in the index by the initials of the inventor. The recent introduction into the manufacture of gum-elastic, of the fibrous fabrics named in this volume—"tissue," "vellum," and "the plated and porous fabrics"—the writer considers next in importance to the discovery of vulcanization; and although they are yet hardly known, they will be found to be the means, more than any other fabrics, of substituting gum-elastic for leather.

As regards the commencement of the manufacture of India rubber, the writer does not claim to be the first who engaged in it, even in the United States. With regard to the origin and the progress of the manufacture in this and other countries, the important facts, so far as he has been able to obtain them, are given under the heads of foreign and domestic manufacture, and in other parts of this work. It is due to say that numerous individuals among his associates and licensees, have done much to facilitate the development of the various branches of the business that have passed into their hands.

Without assuming any thing more than what is strictly true, the author may say, what will be corroborated by all who have any knowledge of his course, that, as relates to his labors previous to the discovery of the vulcanizing process, so in regard to the subsequent improvements, applications, and fabrics, he has, with little reference to personal comfort or pecuniary advantage, applied himself constantly to the development of the subject for the period of fourteen years, without being diverted from the fixed purpose to complete the system of inventions, as presented in this work, avoiding the temptations that often presented themselves, in the profits which might be derived from prosecuting the manufacture of many of the articles, and has made invention and the improvement of gum-elastic his business and profession. With what success, an opinion may be formed from the descriptions presented by this work, also from the specimens which are produced, and the few that are bound

with this publication. Having confined himself to these labors for so long a time, it would have been indeed grateful to the inventor if none of them need to have been made subjects of patents. It is repulsive to the feelings, that improvements relating to science and the arts, and especially those of a philanthropic nature, should be made subjects of money-making and litigation by being patented. The apology he has to offer for doing that which was repugnant to his feelings, is the unavoidable necessity of the case. At different periods during a course of years, he was unable to prosecute his experiments for want of pecuniary means, and was consequently obliged to obtain them of his friends, upon the prospective value of his inventions, through such legal advantage as was to be had under the patent laws.

The question may arise in some minds, How does it happen that in this case the claims of one individual are so extensive, including not only the original discovery, but also embracing a large share of the uses and applications that have grown out of it? The reasons are given at length, under the heads of "American Manufacture," and "Experiments of the Inventor." The principal reason may also be briefly stated here. The general disfavor with which any thing relating to India rubber was regarded in the United States, and the want of pecuniary means to enable the writer to employ others, before, at the time of, and for some time after, the discovery of the heating process, so insulated him from the co-operation, assistance, and sympathy of others, that he was compelled to carry on his experiments alone, and in opposition to the unanimous censure or ridicule of all who were at that time acquainted with him and his occupation.

During the progress of the experiments with the substance, new uses and applications were constantly suggested to the mind of the writer. Many of the articles that are specified and described as new in this work, have been experimented upon at different times, during the period of fourteen years. The two applications that have been last completed and

brought to the notice of the public—carpeting and globes—were among the first that the inventor attempted to make. This accumulation of inventions is the result of years of labor and constant application to the subject.

Fortunately, the substance is one with which, in experimenting, fingers are better than any other mechanical power, of the same force, when the dissolving process is used, which was, before the substitution of steam and pressure, the only one in use. Fingers were the only mechanical power of which the writer had command during the first two years of his experiments, and that by which he mixed and worked many hundred pounds of gum, afterwards spreading it upon a marble slab with a rolling-pin. Thus, owing very much to the plastic nature of the substance, in extreme poverty, he was able to persevere in his course, against all obstacles, and having endured alone the reproaches which were heaped upon him without measure, the recognition of merit is now the more grateful. Whatever of misfortune may hereafter befall him, he will have the satisfaction of knowing that his efforts have been successful, and of witnessing on every side, and in every civilized country, the growing importance of the numerous branches of manufacture already established, and which may in his life-time be established, under these inventions and improvements.

Before dismissing the subject of the writer's claims to important inventions in the treatment of caoutchouc and its compounds, in justice to himself and in anticipation of the future as relates to a mode of treatment in the manufacture which, though lightly esteemed and little thought of now, he believes will be extensively practiced hereafter, especially in the treatment in the kind of caoutchouc called gutta percha, he feels bound to make a strong though qualified claim to the process of solarization. This process consists in exposing caoutchouc, when combined with sulphur, to the sun's rays. The powerful influence of the sun's rays has been known, as relates to its

general effects, since 1837, and was first made known to the writer by N. Hayward; but as to its practical utility, it is not even now publicly known. It was practiced to a very limited extent by the writer and one or two of his licensees, previous to the discovery of the vulcanizing process; but the art being then imperfectly known, was impracticable. The odor of the sulphur, in the quantity in which it was then used in the fabrics, was so strong as not to be endurable, and the practice of solarizing has been abandoned for many years past, excepting where it has been used for drying off the tackiness of goods that were vulcanized. This practice of some manufactories, especially that of the Union India Rubber Company, in the manufacture of garments, is one among other proofs that solarization, to the depth to which it extends, is the most complete vulcanization; but this effect of the process does not extend to any considerable depth, or so as to cure gum of the thickness with which the fabrics were formerly coated. The claim to the new use of solarization, and the rendering of this process practically useful, by the writer, is founded in his discovery that a minute portion of precipitated sulphur—in quantity as small as one ounce to twenty pounds of caoutchouc—was adequate for the desired result; and also in his invention of the "plated" fabrics, by which an extremely thin coat of caoutchouc and its compounds is made to answer a better purpose in all respects than the large quantity formerly used, whereby, on account of the thinness of the "plating" of the fabrics, solarization may be substituted in these fabrics instead of vulcanization. This claim of the writer to the new and improved use of this process is made with the greater force and propriety, for the reason, that up to the time of writing this article, the facts here stated, as to the effects and utility of the process, are generally doubted by those best acquainted with the caoutchouc manufacture. After so great notoriety of the art of vulcanization, wherever he now ventures to advocate his opinions, it is considered little less than heresy for the discoverer of that process to treat of any other as important, and

particularly of one that has been so much and so long discredited and disused.

This view of the subject is taken only because the matter is not understood. The different manner of using it is in fact equivalent to a new discovery; and the rendering of any art available which has been once condemned and disused, is even more difficult than it is to introduce an invention entirely new.

It is less understood that there is in fact no rivalry between the two processes; in other words, vulcanization is not rendered less valuable by solarization: they apply to very different classes of fabrics. While light and the sun's rays operate upon extremely thin coated or plated fabrics, the more intense and artificial heat used in vulcanization accomplishes the more difficult result, of changing the nature of masses of gum of any desired thickness.

With reference to attempts that have been made to deprive the inventor of his rights, he can not refrain from quoting from a poem of Percival, portions of which are appropriate to the case in point, and which will be felt by any one who has been in a similar way wronged, either in authorship or invention.

While thus they are intent
Alone on truth, conscious of that one pure
And single purpose, nor suspecting ill
Of such as they had trusted, thinking too
The world was just, and none would dare to claim
What they revealed,—they find what they had won
By long and earnest toil, by *other hands*
Seized as their own, and shown with vain display
As their *own trophy*, with not even a hint
Whence they had stolen the prize. Is there a pang
Keener than that which runs through all the frame
When the high-minded spirit, who would shrink
Even from the touch of others' rights, first feels
The fruits of years of search, borne from his grasp,
And made the borrowed plumage, to adorn
The week and vain? Yes, they are weak and vain;
Weak, for they cannot vindicate ther claim;
And vain, for *brief* indeed is their display,—
And unsubstantial as the *mists* that shine
In the *new* dawn, and melt as it ascends.

Let none, then, venture to assume as his
The truths a better wins, by long research,
And a far train of thought, that *such* alone
Can sway and turn; for he too soon will find
He cannot use them: they reject his hand,
And, self-conducted, seek their rightful lord.

Irus may steal the exiled hero's *bow*
He cannot bend, and take the ponderous *sword*,
Too weighty for his arm—
So have no fear,
Servant of Nature, that what gems she gives
Thee, from her hidden stores, will ever grace

The poor purloiner's brow—they are thy own!
Nor fear, if what thou knowest is true and just,
And worthy to command the best regard,
And take its place among discoveries
That ever last, *should be* passed silent by,
By such even who pretend to wear the robes
Of nature's priesthood, and so teach the world.

Go on, then, in thy task, unshrinking—seek
What longest sought, at last, when found, rewards
With highest joy—what finding, thou canst say,
I too have found! On nature print thy steps
Deep—as in adamant!—and they will last.
Those of thy *age*, will by the common track
Go smoothly on, nor know nor care that thou
Mid tangled wilds hast found the *only way*
That leads to the true goal. O'er *rugged heights*
It passes, and they choose the easy plain.
But *thou* hast oft on nature pressed thy seal,
And it will hold! Thou, too, in lonely search
Hast notched thy way along the clifted rocks
And mountain summits, and when *others* come
Who *seek*—like thee—they then will find impressed
Thy lasting mark, and know *thou* hast been there,
And traced it all. Then comes thy high reward!
They own thee as their guide, and wide proclaim
Thee a discoverer.
If thou art then
Conscious that thou hast added aught of worth
To the great treasury of mind—new truths
From the wide outer world, or from the world
Within us, or creations new of art,
Sublime or fair, to raise or to refine
The mind and heart—trust to a coming age;
Confide *there*, and repine not; but bestow
All thy best gifts on such as pass thee by,—
Even as if best rewarded; good for ill!

INSCRIPTIONS ON MEDALS, TESTIMONIALS, ETC.

Certificates from L. D. Gale; Prof. B. Silliman, and Proffs. J. C. Booth and H. M. Boye. Copyright of original Specification of Patent, 1841.

As a part of the history of the origin of these discoveries and inventions, there are here given copies of a few Certificates, Testimonials and Reports, made at an early date by individuals who at the time of writing them gave particular attention to the subjects alluded to by them respectively. The names of the authors of these papers, with whose high standing the public are well acquainted, render it unnecessary to do any thing more than present them. It may however be observed that they are given by parties who would not be likely to be ignorant of facts in chemistry relating to a radical change in a raw material, which change had long been a public desideratum.

INSCRIPTION ON A MEDAL OF THE AMERICAN INSTITUTE, NEW YORK, 1835.

"Awarded to Charles Goodyear, for a new discovery in India rubber."

INSCRIPTION ON A MEDAL OF THE MECHANICS' INSTITUTE, NEW YORK, 1835.

"Awarded to Charles Goodyear, for a new method of manufacturing India rubber."

INSCRIPTION ON A MEDAL OF THE AMERICAN INSTITUTE, NEW YORK. 1836.

"Awarded to Charles Goodyear, for India rubber drapery not liable to decomposition from exposure to the sun."

INSCRIPTION ON A MEDAL OF THE MECHANICS' INSTITUTE, NEW YORK, 1836.

"Awarded to Charles Goodyear, for the application of India rubber to printing."

INSCRIPTION ON A MEDAL OF THE AMERICAN INSTITUTE, NEW YORK, 1844.

From the time of obtaining the medals in 1836, no public exhibition was made by the writer until 1844, when a general assortment of vulcanized fabrics and goods, including harness, shoes, buckets, &c., was exhibited at the fair of the American Institute at New York, for which a gold medal with the following inscription was awarded :—

"Awarded to Charles Goodyear, for the best sheet rubber shoes, India rubber cloth, and an assortment of harness, buckets, &c."

INSCRIPTION ON A MEDAL OF THE MECHANICS' ASSOCIATION, BOSTON, 1844.

"Awarded to Charles Goodyear, for superior India rubber goods."

INSCRIPTION ON A MEDAL OF THE FRANKLIN INSTITUTE, PENNSYLVANIA, 1844.

"Awarded to Charles Goodyear, for gum-elastic goods."

PROF. L D GALE'S CERTIFICATE.

ACID GAS PROCESS.

I have made a course of experiments from information confided to me by Mr. Charles Goodyear, in relation to his method of the manufacture of India rubber, and have the satisfaction to say, that the result has been perfectly successful.

The gum, reduced to the consistence of stiff paste, by means of common spirits of turpentine, which requires no purification, is again restored to its original elasticity and imperviousness. The viscous, or adhesive property which belongs to the gum in its natural state, and which is increased by the solvents generally used, has heretofore presented all the obstacles to the success of the manufacture and uses of this article. The process of Mr. G. by which this difficulty is removed, depends on chemical principles, which are fixed and invariable, and there seems to be no possible obstacle to its practical application.

L. D. Gale,
Prof. Chem. N. Y. College Pharmacy, and Prof. Geology and Mineralogy N. Y. University.

New York, *Sept.* 1, 1835.

Note.—This certificate was given before the process was made public, to satisfy the inquiries of private individuals.

PROF. SILLIMAN'S CERTIFICATES.

FIRST MANUFACTURE OF DRAPERY OR SHEET INDIA RUBBER.

New Haven, *June* 15, 1836.

Mr. Charles Goodyear has submitted to me, and to my inspection, a process by which he dissolves Caoutchouc, or India rubber, with common spirits of turpentine; and then by another process he restores it again, so as to form a thin sheet, or fabric, without tissue.

This fabric is divested of the clammy qualities that exist in the native elastic gum. So far as I am informed, both the process and the effect are new, as has been already observed by the Mechanics and American Institute in New York, as indicated by the silver medals bestowed by them on Mr. Goodyear, and now in his possession.

B. Silliman.

I would mention that Mr. Goodyear has prepared his elastic gum in my presence, by spirits of turpentine, and then brought it back without mixing or blending any other substance with it, so that it becomes again strong India rubber, but free from any clamminess; and feeling, when pressed between the hands, like linen or cotton.

B. Silliman.

June 16, 1836.

Having seen experiments made, and also performed them myself, with the India rubber prepared by Mr. Charles Goodyear, I can state that it does not melt, but rather chars, by heat, and that it does not stiffen by cold, but retains its flexibility in the cold, even when laid between cakes of ice.

B. Silliman.

Yale College, *Oct.* 14, 1839.

PROFS. BOOTH AND BOYE'S REPORT.

METALLIC OR VULCANIZED GUM-ELASTIC.

COPY.

PHILADELPHIA, *Dec.* 18, 1844.

TO MR. CHARLES GOODYEAR.

Dear Sir,

Having completed a series of experiments upon the Metallic Gum-Elastic Composition, we submit to you a report of our conclusions deduced from the same; merely premising that the conclusions agree so closely with the results attained by us, in researches on the same material some *two years since*, the remarks are wholly applicable to both series of experiments. The experiments instituted were both mechanical and chemical.

1st. Chemical tests.

This composition differs remarkably from common gum-elastic in its chemical behavior.

By the application of degrees of heat at which organic substances are very much injured or destroyed, it remains unaffected, and requires an unusually high temperature to soften it; about the same, it would appear, as causes it to inflame.

It resists, in a powerful manner, those chemical agents which rapidly destroy, dissolve, or soften common gum-elastic. Long continued immersion in the usual solvents of gum-elastic, does not produce solution; a shorter period of contact or immersion seems to have no effect upon it.

Strong oil of vitriol and nitric acid char it only after continued contact; a shorter time of immersion, or somewhat diluted acids, produces no effect. Boiling water and alkaline liquids produce no effect upon it, unless the latter be very concentrated and boiling, and even then the effect is a trifling diminution of its tenacity.

It will be observed from the above behavior, that it resists chemical tests in a manner superior to organic substances.

2d. Mechanical tests.

It possesses all the usual properties of common gum-elastic, but it far surpasses the latter in the degree of these properties.

Its tenacity, or the force which it opposes to rupture, is much greater than that possessed by ordinary gum-elastic; we have not submitted it to direct measurement, but a simple practical test convinced us of its superior tenacity.

When opposed to great degrees of cold, even below 32°, it appears to be undiminished in its elasticity, flexibility, and tenacity, in which valuable property it differs so strikingly from ordinary gum-elastic, that this alone, if it possessed no other superiority over common gum, would entitle it to the praise of being the greatest improvement in the manufacture of gum-elastic.

We have had pieces of it lying for two years in our laboratory, and during the same period have repeatedly employed portions of it for connecting apparatus, and for other purposes, and we find that it resists mechanical abrasion, as well as chemical action, powerfully; nor have we found it touched by vermin, nor altered in the slightest degree.

Besides the above properties, resulting from experiments, there are others evident to those who have examined the goods manufactured from the metallic gum-elastic composition; such as the ease with which it may be wrought into an infinite variety of goods, adapted to almost every variety of purpose; the ease with which it receives color, the finest lines of printing, &c.; but as these properties may be more or less understood by a simple inspection of the goods, we forbear taking farther notice of them.

In conclusion, we cannot but draw the inference from our own experiments, and from an examination of the different kinds of fabric made from this singular composition, that it far surpasses all other attempts made to manufacture gum-elastic goods.

Respectfully yours,

(Signed,) JAS. C. BOOTH AND H. M. BOYE.

COPY OF ORIGINAL SPECIFICATION OF PATENT, 1844, AS LEGALLY PREPARED IN 1841.

TO ALL PERSONS WHOM IT MAY CONCERN.

Be it known that I, the undersigned, Charles Goodyear, of Boston, county of Suffolk, and commonwealth of Massachusetts, have invented a new and useful improvement, called Goodyear's Patent Fabrics, of which the following is a full and exact description.

These fabrics are made of a compound of gum-elastic, sulphur and white lead, mixed with different kinds of fibre, such as cotton, wool, flax, hemp, leather, and hair; and also applied to different kinds of cloth, cordage, leather, paper, &c.

The compound is made as follows, viz.:—

One pound of gum-elastic,
One quarter to half a pound of sulphur,
One half to one pound of white lead.

The gum is dissolved, and the white lead and sulphur are ground, in the usual method known to manufacturers, with spirits of turpentine.

When this compound is mixed with fibrous substances, I think it quite necessary that the gum should be dissolved as above, the different substances being thoroughly mixed with each other. When the fibrous substance has sufficient length of staple to be formed into a sheet or web like cotton wadding, I prefer applying the compound to it in the same way in which it is applied to cloth or leather by callenders, instead of mixing it with the compound, and when the compound is applied to cloth or leather without the fibre, it is done with the various kinds of machinery made use of by India rubber manufacturers.

The compound without fibre may be mixed and ground thoroughly together dry, and applied to cloth, leather, or a sheet or web of fibre, with heated callenders, without the use of tur-

pentine to dissolve the gum as above specified. Another fabric is made of this compound alone, without any other substance, by spreading it upon any smooth article or glazed cloth, or upon that which I prefer to any thing else, a web of cloth, manufactured and finished according to this specification. This fabric is found very superior on account of its elasticity, delicate texture, and adaptation to surgical uses. It will be understood, that after the compound is sufficiently dry, it is removed from the cloth. By this method I also manufacture a fabric of pure gum-elastic, for which letters patent were granted me, June 17, 1837.

When these several fabrics are sufficiently dried, either in a heated room or by the weather, they are then exposed to a high degree of heat, say about two hundred and seventy, by running the fabrics between heated callenders, or before or through a furnace or oven, or a heated metal plate. I consider the best method of doing it before or between plates, at a little distance therefrom; when the fabrics are first made into various articles for which they are adapted, they are placed in an oven, and baked with the required degree of heat; or they may be immersed in any article that is melted or fluid, at about the degree of heat herein specified.

The effect of the heating process is to improve very much the quality of the fabrics; previous to this they have a resemblance to, and are liable to some of the objections of, India rubber goods generally, but afterwards they are by this method every way improved, and in no way injured, excepting that the fabrics which can otherwise be made of fancy colors, are changed in color to a brown.

Being finished in this manner, these fabrics are not injured by any kind of oils, and cannot be made adhesive by them, or in any other method of which I have any knowledge, nor are they soluble like gum-elastic in spirits of turpentine, or other essential oils; although by long exposure to them they may be made somewhat tender and pulpy, yet they resume their original strength when the oils are allowed to evaporate.

They are not stiffened by cold, or melted by any degree of heat, unless placed in the fire.

In some cases, when a fabric of a light color is desired, I dispense with the sulphur and white lead, and after it is finished I boil it in water with sulphur, or expose it to the weather, and especially to the sun's rays, after having brushed it over with the flour of sulphur while it is yet adhesive. The effect of the sulphur applied in this way, is to destroy entirely all the adhesive properties of the gum-elastic.

In order to cleanse and free the goods from the sulphur, and from the smell of sulphur, I boil them in lime, potash, and other alkalies.

In the manufacture of these fabrics, the proportions of the lead and sulphur may be considerably varied, and oxides of metals generally, or other pigments, may be substituted for the lead.

Signed in our presence, December 6, 1841.

J. W. Roberts,
Geo. Buckland.

Charles Goodyear.

The improvement which I claim, and wish to secure to myself by letters patent, consists in compounding the fabrics with a large proportion of sulphur and white lead, as herein specified; and the fabrics being thus suitably prepared to endure the heat, and in next applying a high degree of heat, whereby the impurities of the fabrics are entirely removed, as herein specified, or in any manner analogous thereto.

I also claim as my improvement the use of fibrous substances, either with gum-elastic, or this compound being mixed with the same, or made use of in the sheet or web.

I furthermore claim as my improvement the India rubber fabric without tissue of any kind, and the boiling and drying India rubber goods in contact with sulphur, and afterwards cleaning them with potash, or other solvents of sulphur.

In testimony whereof, I, the said Charles Goodyear, hereto

subscribe my name, in the presence of the witnesses whose names are hereto subscribed, on the 6th day of December, Anno Domini, 1841.

On the sixth day of December, 1841, before the subscriber, a Justice of the Peace, in and for the county of New Haven, State of Connecticut, and authorized by law to administer oaths, personally appeared Charles Goodyear, and made oath that he verily believed that he is the first and original inventor of the improvement above-mentioned and described in the specification by him subscribed, and that he does not know that the same was ever before known or used, and that he is a citizen of the United States.

Dennis Kimberly,
Justice of the Peace.

The foregoing document was legally prepared at the period of its date by a distinguished counselor of New Haven, whose signature it bears. It was deposited in the Patent Office of the United States as a caveat or claim of the invention, instead of application being made under it for a patent, as was first intended. Some of the reasons why application was not made for a patent until 1843, have been before mentioned; they are more explicitly stated as follows, viz.:

1st. The pecuniary embarrassments of the inventor at that time were such, that he was unable to manufacture articles to demonstrate the utility of the invention, and the state of the public mind was such, owing to the losses which had been sustained by those who had attempted the manufacture of caoutchouc in the United States, that no one was willing to co-operate with him for this purpose; consequently the discovery was not then appreciated by others as it is now.

2d. It was also important to ascertain, previous to the application for a patent, whether there might not be found some substitute for sulphur, which was then considered objectionable in the vulcanizing process.

3d. Under the circumstances above stated, there was danger

that the patent, if issued, would be lost to the inventor, his creditors, and the world. That his object was not to withhold from his creditors the avails of these inventions when rendered valuable, ample proof has been given.

4th. The inventor was very solicitous to secure patents in foreign countries, where the laws required that, in order to render a patent valid, the application should be made simultaneously with that in the United States, and he had not the means of making these several applications until 1843, when they were made in the United States, England, and France. Since the year 1844, numerous patents have been taken out, both in the United States and foreign countries, for modifications of the vulcanizing process; and it is worthy of remark, that in none of these is there any attempt to dispense with the two essential agents, sulphur and a high degree of heat, which alone are indispensable in effecting the change in the properties of the gum by vulcanization, and that these two agents, sulphur and a high degree of heat, are distinctly claimed in the foregoing document, signed and sealed in 1841, as well as the writer's patents issued in this and foreign countries in 1844.

The writer has intentionally omitted all mention of the English patent for the vulcanization of caoutchouc, enrolled by Thomas Hancock on the 30th May, 1844, and also from expressing any views or opinions in relation to the circumstances under which this patent was taken out, lest he might possibly do some injustice to Mr. Hancock or his partners, Messrs. Macintosh and Co., the owners of the English patent. The invention patented by Mr. Hancock is the same as that so fully described in this volume as the heating or vulcanizing process discovered by the writer in 1839. He hopes before long to have the advantage of a personal interview with Messrs Macintosh and Co. and Mr. Hancock, after which he will be better prepared to state his views on this subject.

CHAPTER VII.

EXPERIMENTS OF THE INVENTOR.

Influences which led the author to the discovery of his invention. Some particulars of the author's personal history; his apprenticeship. Commences in the domestic hardware and commission business. Visits the store of the Roxbury India Rubber Company in New York. Commences the manufacture of India rubber goods at New Haven. Meets with difficulties. Removes to New York, and continues his experiments. The acid gas process. Obtains a patent. The new articles are introduced into England by Dr. Bradshaw, and a patent taken out in that country by Mr. Hancock. Visits Roxbury, and prosecutes his labors with more success Grants licenses. Experiments with sulphur. Result of an experiment. Embarrassments of the author. Discovery of vulcanizing. Results of previous failures. Difficulties to encounter. Incidents attending the discovery. First successful operation.

Whenever any great improvement is made, or effects worthy of special attention are produced, the tracing of them to their first cause is a subject of interest to most minds, and with some a constant habit.

In reference to the discovery of vulcanized gum-elastic, the question is frequently asked by those who know that the inventor makes no pretensions to a knowledge of chemistry, and that for many years he pursued a widely different occupation, what first turned his attention to gum-elastic, and what was the influence that led to such continued application, to an undertaking apparently so hopeless?

To this the writer may reply, that from the time his attention was first given to the subject, a strong and abiding impression was made upon his mind, that an object so desirable and important, and so necessary to man's comfort, as the making of gum-elastic available to his use, was most certainly placed

within his reach. Having this presentiment, of which he could not divest himself, under the most trying adversity, he was stimulated with the hope of ultimately attaining this object.

Beyond this, he would refer the *whole* to the Great Creator, who directs the operations of mind to the development of the properties of matter, in his own way, at the time when they are specially needed, influencing some mind for every work or calling. The creature may imagine he is only executing some plan of his own, while he is the instrument in the hands of his Maker, contributing to execute his purposes, which, though we cannot fathom, we may believe involve, with the highest elevation of mind and morals, the highest improvement of things material.

However foreign to the subject this expression of the writer's sentiments may appear to some, he knows there are those who will respond to them as not unsuitable to the occasion, or a digression foreign to the work. Were he to refrain from expressing his views thus briefly, he would ever feel that he had done violence to his sentiments.

Some particulars of the personal history of the inventor are necessarily connected with the following account of his experiments, the publication of which is deemed important to the objects of this work; and the incidents related as connected with them, may not be uninteresting.

Early training and subsequent experience, had probably much to do in fitting the writer for an enterprise which he has since so ardently pursued. In his business intercourse, previous to the undertaking, he had been brought in contact with those engaged in most of the different pursuits of life. Thus he early acquired habits of observation and attention to their wants; by which he was afterwards guided in his pursuit of improvements, whether of farming implements and small hardware, or the various appliances of gum-elastic.

He does not claim to have a mechanical talent, but, on the contrary, has an aversion to bestowing thought upon machinery when there is any thing complicated about it.

The machinery which he has been compelled to invent, for

putting in operation his improvements, viz., the shirring, cording, and napping machines, are of the most simple construction; and are just such as should be suggested to the mind of any person requiring machinery for these purposes.

Independent of all pecuniary considerations, he has taken great satisfaction in trying to improve articles of necessity or convenience, for the use of man. Those which first engaged his attention were in the hardware line, and such as were immediately connected with his occupation. Whenever he observed an article in common use, in which there was obviously a great defect, whether growing out of the choice of unsuitable materials for the purpose, or in consequence of a wrong construction of the thing, he commonly applied his mind to the subject, to find, if possible, the best way of improving it, or removing the defect, always contesting the common maxim, that for the interest of the trade, "things should be so made that they will not *last too long*." A theory, the fallacy of which is only equalled by the demoralizing influence of the sentiment, and the pecuniary loss both of the mechanic or manufacturer, and the consumer. The more completely things are made, the more satisfaction and enjoyment will be found in their use, and the greater will be the demand, especially as nothing can be so well made but that time will dispose of it in some way.

The imperfections of these things, many of which are looked upon only as trifles, of no sort of consequence, he considered as of great importance, as not only the cause of much waste of time and money, but also productive of great moral evil. Nor is it exaggeration to say, that a great proportion of the annoyances that disturb the mind, and give rise to such evils, arise from the use of articles badly constructed, or from some cause not fitted to the use for what they are intended, to say nothing of their being the immediate cause of serious harm.

"And the cable of a furlong is lost through an ill-wrought inch."

At this early period, the manufacture of cotton and wool, except in families, was hardly commenced; and the manufacture

of hardware, except by the country blacksmith, was scarcely thought of. The manufacture of hardware was engaged in by Mr. Amasa Goodyear, during the writer's boyhood; and when not at school, he was more or less occupied with the various branches of his father's business, such as making military and other kinds of metal buttons, spoons, scythes, and particularly the spring steel hay and manure forks, universally considered in the United States one of the greatest improvements ever made in farming implements. He was also made familiar with farming operations, which were always attended to by his father, in connection with his other business.

To all of these occupations, as well as his subsequent hardware apprenticeship, he applied himself with intense ardor and delight. From the age of seventeen to twenty-one, he served an apprenticeship at the hardware business, with the firm of Rogers & Brothers, Philadelphia, at that time one of the most extensive wholesale importing houses in the United States.

By close application and hard labor in this business, his health became much impaired, so that at the expiration of his apprenticeship, he was greatly disappointed by being obliged to abandon the idea of establishing himself in the business he had designed to pursue.

During the next five or six years he was engaged with his father, under the firm of A. Goodyear & Son, in the manufacture of the hardware spoken of, and also of clocks. The most important article manufactured by them at that time, was the spring steel hay and manure forks, introduced into use by the senior partner in 1810, which business has continued to increase to the present time, to the great benefit of the farming interest, throughout the United States.

The reputation of these and other farming implements of their manufacture, subsequently gave to the inventor many advantages for establishing himself in the domestic hardware business; and it was the observation of the good done in the community, together with the advantages derived from the manufacture of these improvements, that gave a bias to his whole future course

of life, and gave stimulus and energy to his efforts to improve gum-elastic.

That the reader may better understand how so great an improvement can be claimed for an implement of husbandry so simple, it may be well to describe those that were previously used. They were made by the country blacksmith, of iron, very large and heavy, and were very easily bent and battered at the points, and would now no sooner be used than the wooden plough of the ancients.

So completely has the article formerly used been superseded by this improvement, that the rising generation of farmers do not know what article their fathers were obliged to make use of.

In 1826, the writer removed from Connecticut, with his family, to Philadelphia, and engaged in the domestic hardware and commission business, in connection with the manufacturing establishment in Connecticut, which was carried on under the firm of A. Goodyear & Sons. This was the first establishment for the sale of domestic hardware in the United States. It was regarded by many as a visionary enterprise, for to that time the whole trade in hardware had been in imported articles. The predictions of that time in regard to this business were not, however, verified; for it was eminently successful, and, like the domestic dry goods business, it soon became an extensive department of trade, which is constantly increasing.

It will be remembered by many hardware men of the present day, that from 1826 to 1830, the inventor was known in our commercial cities to be the pioneer in domestic hardware, by which, and the manufactory alluded to, a handsome fortune was accumulated by the firm, and the writer occupied a position in business every way desirable; but in consequence of too extended operations in different States, too liberal credits, and heavy losses in 1830, they were obliged to suspend payments.

After consulting with the creditors of the firm, they were induced to continue their business with extension of payments. This was considered unavoidable, on account of the amount of

property invested in manufacturing establishments. The writer did not count upon the disadvantages he had to contend with, on account of impaired credit, and did not know, what experience has since taught him, that under circumstances of embarrassment, the only wise course is not to continue the same business, at least not to continue it under suspended liabilities; although it is often for the interest of the creditors at the time, that this should be done.

The course he adopted was attended with continued embarrassment, by the shifting of claims into the hands of strangers, and by being held by them to bonds in different States. He could not make an assignment without divesting himself of the titles to his unfinished inventions, in which state they would have been of no value to himself or to his creditors. Under the laws that then existed, during the space of ten years he was repeatedly imprisoned for debt; but, notwithstanding the depressing influences of these circumstances, he assiduously applied himself to the improvements before alluded to, and shortly before he engaged in experimenting upon gum-elastic, (while confined upon the jail limits,) he completed one of these improvements, from the sale of which he derived the means of subsistence for himself and family. His anticipations of ultimate success in life were never changed, and his hopes were seldom for a moment depressed.

These trials were not wholly without their advantage; lessons of life were learned from them. If any one is desirous to learn more of human nature than he can learn in any other way, or wishes for a moment to look upon the darkest side of life's fleeting shade, let him, for such a cause as debt and misfortune, be placed within the bars of a prison door, without a dollar in his pocket, and in conscious innocence look out upon the world, and reflect upon the wide contrast in his condition with that of those who are enjoying liberty without; while within he finds his fellow sufferers all upon the same level, whether incarcerated for the sum of one hundred pence, or of one hundred thousand pounds. Then, notwithstanding the

mortification attending such a trial, if he has (as every human being should have,) a good purpose in life for which to live and "hope on," he may add firmness to hope, and derive lasting advantage by having proved to himself, that, with a clear conscience and a high purpose, a man may be happy within prison walls, as well as in any other (even the most fortunate,) circumstances in life.

In order to cancel a large portion of his indebtedness, he was induced to dispose of the good-will and the control of the steel fork manufacture, retaining an interest in it with his successors. This interest he subsequently relinquished for a similar purpose.

The monopoly of this branch of industry had remained with the senior partner and the firm for more than twenty years, and it was with real regret that the writer parted with the last pecuniary advantage of a business, from which he had, for many years, anticipated an independence for life. At this period he relinquished all interest in the manufacturing firm in Connecticut, without obtaining a discharge from their former liabilities, upon which he was subjected to the imprisonments and embarrassments alluded to.

In reflecting upon the past, as relates to these branches of industry, the writer is not disposed to repine, and say that he has planted, and others have gathered the fruits. The advantages of a career in life should not be estimated exclusively by the standard of dollars and cents, as is too often done. Man has just cause for regret when he sows and no one reaps. And, besides, he was, for many years, amply compensated in a pecuniary way; and it is also a satisfaction to know, that among the numerous domestic hardware houses that have since been established in all our large cities, two* of the most respectable and wealthy are the immediate successors of the original firm.

A short time previous to his failure in Philadelphia, two other improvements, which were the invention of others, engaged his attention. These were unsuccessful at the time. They are alluded to here as deserving of notice, first, because they

* Messrs. Heaton & Denckla, and Messrs. Curtis & Hand, Philadelphia.

were among the principal causes of his failure; not so much in consequence of the amount of money lost by them, as on account of the effect the speculation had on his credit as a merchant; also, because they are rendered much more complete by the improvements in gum-elastic, and because he is as confident now as ever, that the inventions have in themselves intrinsic merit, and will probably, at some future day, be thought by others worthy of attention, as matters of improvement.

The two inventions above alluded to, the Stella-rota and Self-winding Clock, are described among the applications of gum-elastic, in Vol. II.

All who have had experience with inventions, know full well that it requires a vast deal besides merit in an invention to make it successful; it must not be too far in advance of the age; besides, it requires much time and persevering effort to introduce a new thing into use, be it ever so good; and, sometimes, the better it is, the longer it takes. Sometimes the great contrast in things that are improved, with those for which they are to be substituted, seems only to excite the incredulity of mankind.

This was particularly the case with the cast-iron plough, and the improvement in forks. The inventors and introducers, in many cases, thought themselves highly favored when an influential farmer consented to give them a trial, when they were presented to him.

The writer has in mind instances in which they were absolutely refused, when presented, on the score of unbelief, from the articles being so light and well-finished.

Oftentimes things of little or no value catch the public favor, and, by being prosecuted by shrewd and discerning individuals, large fortunes are made by them. The wonders of the day explode, and are never heard of afterwards. At this period it became with the writer a serious question what he might do next, with any prospect of success. Foreseeing that he should not be likely to shake off the epithets of inventor, mechanical genius, or visionary, which terms are generally considered as synonymous, and diametrically opposed to money-getting—all

things considered, he determined to make a profession of invention. So completely was he hemmed in by the difficulties here stated, that he could not hope to recover himself by any ordinary business, in competition with others; he therefore sought some new field of enterprise suited to his capacity, and congenial to his wishes.

He was sanguine that if he could find one in which he could turn to account his past experience, he might retrieve his fortunes. Having been compelled to relinquish a business that was profitable and agreeable, and which was not subject to the evils and annoyances arising from all business exposed to competition, he was desirous, if possible, in making another choice, to select something that would restore him to his former position.

From what has been related, it would appear that, although the business in which he was about to engage was new to him, and very different from that of hardware, he was no novice in relation to improvements. In boyhood he had been inured to labor, and subsequently had been disciplined in adversity; and, considering his indebtedness to others, and the dependence of a family upon his efforts, he was prepared with a stout heart to enter upon any enterprise where he could reasonably anticipate success. What directly influenced him in the choice of gum-elastic, may be inferred from the following particulars.

When yet a school-boy, the wonderful and mysterious properties of this substance attracted his attention, and made a strong impression on his mind. A thin scale, peeled from a bottle or a shoe, sometime afterwards attracted his attention, and suggested to him that it would be very useful as a fabric, if it could be made uniformly so thin, and could be so prepared as to prevent it adhering together and becoming a solid mass, as it soon did from the warmth and pressure of his hand.

About the year 1831 or 1832, the manufacture of gum-elastic was begun in the United States, though not in the immediate vicinity where he then was. He observed all that he heard or

saw relating to it, with a good deal of interest. Some time subsequently he was passing the store of the Roxbury India Rubber Company, in New York, and stopped to make inquiry about life-preservers, with the view of purchasing one. On examining the tubes by which they were inflated, it occurred to him that he could improve their construction. Some months after this, he presented a specimen of his improved tube to the agent of the Roxbury Company, with the view of disposing of it to that company. Being pleased with his success in that, the agent advised him to turn his attention to the improvement of India rubber, and said, in behalf of the company, he would insure a very large compensation to any one who would overcome the great difficulties they met with in the manufacture, which were, great adhesiveness and subsequent decomposition of the goods.

He was also informed that the losses of the different companies had been great, in consequence of these difficulties, and that unless they could be removed, the business must, in all probability, prove a failure.

He was not before aware that the manufacture was so imperfectly understood. He was blessed with ignorance of the obstacles which he had subsequently to encounter, but soon learned this much, at least, that the difficulties which attended experiments with the substance, if not unparalleled, were of an uncommon character, from the fact that the experimenter, as well as the manufacturer, was obliged to wait the return of both warm and cold weather, at least twelve months, and often longer, before he could know with any certainty that his articles would not decompose, or what were the results of his labors. It is now a well-known fact, that even the metallic or vulcanized articles, if not properly made or thoroughly heated, will decompose, the second year, after they have remained apparently sound the first year. Especially is this the case when the goods have been manufactured with the use of turpentine.

These facts account, in a great measure, for the time spent in experiments upon this substance before the discovery was made, and the object so long sought for gained. The same facts, also,

account for the heavy losses sustained by the different companies referred to, in the article headed American Manufacture. The goods which were made in large quantities during the winter, decomposed on the return of warm weather, and were a total loss. The subsequent experiments of the inventor were attended with the same results. The hopes which had been raised by his apparent success, were repeatedly dissipated by the gradual fermentation of the goods on the return of warm weather.

He had not proceeded far in his experiments, before he learned the fact, that the substance had baffled all the efforts of chemists and manufacturers, to divest it of its objectionable qualities. He not unfrequently met with physicians and others, who had made a long course of experiments for this purpose, but who had only met with disappointment. The attention of individuals of the medical profession was probably drawn to this substance before that of any other class, from the fact that gum-elastic was found useful for medical and surgical purposes. A description of articles of this class will be found in the list of applications.

The inventor was, however, encouraged in his efforts by the reflection, that that which is hidden and unknown, and cannot be discovered by scientific research, will most likely be discovered by accident, if at all, and by the man who applies himself most perseveringly to the subject, and is most observing of every thing relating thereto. This fact is corroborated and illustrated by the circumstances attending this discovery, and, in all probability, had it not been made by perseverance against the probabilities of success, it never would have been made at all; for it was well established that India rubber melted at a heat of about 200 degrees, Fahrenheit, and in the sun's rays at 100 or less. India rubber manufacturers had always been careful to avoid a heat of more than 100 degrees of Fahrenheit in the manufacture of their wares; and in the case of the Macintosh goods, their circulars cautioned customers not to approach too near the fire with them. No one who had any knowledge of the nature of the gum, would be likely to apply a high degree of

heat to it from design, or for the purpose of divesting it of the objectionable quality, adhesiveness, when it was so well known that it would melt at a low temperature. It is the use of a high degree of heat, an agent so destructive to the native gum, which forms the broad distinctive feature which characterizes this process. And to this time it appears to be utterly impracticable to apply this high degree of heat to the gum, except in combination with sulphur, in some form or other. There have been, however, many modifications of the process, and attempts at evasions of the patents, by combining with them other substances that are wholly inert, and not necessary to produce the best result.

Among many experiments for drying and curing the gum, (supposing the only difficulty with it to be too great adhesiveness,) the inventor was much elated with the result of one, which was then every way satisfactory. By this experiment, from one half to a pound of magnesia was mixed with the pound of gum. This compound had the great advantage of being white, which was very desirable for many purposes, as no India rubber goods except black had before that time been made in the United States, and no India rubber fabrics in Europe, but those of the Macintosh manufacture, in which the gum is put between two cloths. He then supposed that magnesia, in combination with gum, had the effect to dry it, which some other substances have to dry paints.

A book was bound with this compound, (made without sulphur,) in 1834, the cover of which softened and fermented at that time, but is now hard as shell. It is known to chemists that magnesia and turpentine make a hard substance, and this appears to be only a chemical result of the same character.

A compound is now made by the metallizing or vulcanizing process, with calcined magnesia combined with the gum, which has a peculiar hardness and solidity, and which it is thought makes it better adapted to some particular uses than the ordinary compound of vulcanized gum-elastic ; and it has not yet been found to change or become too hard by age, like the article above described.

The inventor commenced his experiments in a small dwelling, mixing the gum by hand, and spreading it upon a marble slab with a rolling-pin. He here also commenced the art of embossing on glazed cambrics. It was now supposed by himself as well as others, that his success in the treatment of gum-elastic warranted his attempts to manufacture the goods.

By the disinterested and timely aid which was gratuitously offered him by a gentleman of New Haven,* he was enabled to commence the manufacture on a small scale, pulling and kneading the gum by hand, and spreading it with an iron pin upon a marble slab, as above stated. With the aid of a few hands, he succeeded, among other things, in the manufacture of a few hundred pairs of shoes from the embossed goods, which would even now be considered beautiful.

Being impressed with the idea that the difficulties which were met with in the manufacture of the gum, were attributable to the solvents which were used, he considered himself fortunate at this time to find in the market some forty or fifty barrels of India rubber sap, among which were a number of casks in which the gum had not coagulated. It was said to be kept in that state by mixing a portion of alcohol with it, before it was exported from Para. The inventor now hoped to surmount all difficulties by using the sap in this liquid state, if he failed to succeed with other experiments.

A son of Erin, who had been employed to work at the gum, had imbibed the same idea from his employer, and was beforehand in putting it in practice. On the arrival of the barrels containing the sap, he opened one at night, and on meeting his employer at the shop in the morning, Jerry good humoredly signified to him that he had supplanted him, and that a Yankee was not so quick at inventing as an Irishman, at the same time pointing to the trowsers he had on, which he had dipped in the barrel of sap. The job was so completely done, that at first the impression was produced that the improvements were completed, and that experiments with gum-elastic were nearly at an

* Ralph B. Steele, Esq.

end. Jerry sat down to his labor of mixing gum before the fire, as usual, and on attempting to get up again a few minutes after, he found that he was not only cemented to his seat, but that his legs were cemented together. On being extricated from his improved trowsers, to the no small merriment of the bystanders, he subsequently manifested no further inclination for invention.

This experiment was a convincing proof that adhesiveness was a property which belonged to the gum, and was not the consequence of imperfect manufacture.

The manufacture of shoes was carried on during the winter of 1835—'36, in the small cottage which served also as a family residence.

The service which the shoes rendered, when put on trial, was by no means satisfactory, but it was thought that their construction would be so improved as to make them durable, if the gum did not decompose. In order fully to test the quality of the gum, before submitting the shoes to public trial, they were stored; and on the return of warm weather they were found to be one mass of melted gum.

The failure of these experiments was a signal one, and the trial to the experimenter was greatly aggravated from the fact that he had previously given his friends sanguine assurances of his success. They now became disheartened, and declined lending him further assistance for such purposes, and those who afforded his family supplies signified they could do so no longer. At this period he was unable to meet his current expenses; he therefore sold, for the payment of those who had afforded him assistance, the little furniture he possessed.

Having placed his family at board in a retired place in the country, leaving as collateral security, for the rent of his cottage, among other things, the linen spun by his wife, he went to New York to continue his experiments. During his absence these articles were sold at auction for the payment of rent. The loss was, at that time, cause of much regret, and the memory of the time is still cherished, when the daughters of New

England spun their own linen, and the fathers and brothers were clad in the manufacture of the housewife.

The writer is well aware that in alluding to incidents of this kind, he is speaking of things that are in themselves unimportant. They are but trials that are common to the lot of humanity. But it often happens that the merest trifles assume a degree of importance from their relation to a particular subject, or the state of mind of the individual affected by them.

An accident causing detention on a journey, when one is at leisure, may become a source of amusement, while the same accident occurring at another time, would be attended with extreme suffering to the individual, and with serious consequences to others, for which reason it might deserve to be recorded.

On arriving at New York, the inventor was kindly furnished with a room in which he might continue his experiments, by a friend.* A druggist† with whom he was acquainted, supplied such drugs as were necessary for his experiments. He was soon led to suppose that the decomposition of the goods previously made in New Haven, was the effect of the turpentine, and he now supposed that he had discovered a remedy, by boiling the articles compounded with magnesia in quick lime and water, which appeared to have the effect of tanning the gum, and destroying its viscous property.

He made by this method some beautiful specimens of fancy articles, and some sheets of India rubber, for which, in the autumn of 1835, medals were obtained at the fairs of the Mechanics and American Institutes. The improvement was then supposed to be complete, the surface of the articles was quite dry, having just the appearance which the fabric has that is now called gum-elastic drapery.

These were the first sheets of gum manufactured in any country, and were considered great curiosities, as well as a great improvement, for which he obtained letters patent, the day of . In a few weeks, however, he was greatly disappointed to find that when the goods were washed with weak

* Mr. J. W. Sexton.

† Messrs. Silas Carle & Nephew.

acid they became as adhesive as ever, and the lime which adhered to the surface was neutralized, and that the lime had only a superficial effect upon them, although fermentation and decomposition were prevented by the evaporation of the turpentine, caused by the heat of the water.

In addition to the experiments that are now noticed, the inventor prosecuted numerous others, not noticed in this work, by which his hopes were raised for a few weeks or months, only to be disappointed.

He next attempted the mixing of quicklime with the gum, which at first appeared to act as a dryer, but this article was too powerfully caustic to be worked by hand. He therefore obtained access to the mill of a Mr. Pike, in Greenwich, now a part of New York, who was at that time making some of the common India rubber fabrics by horse power. Here he earnestly prosecuted this experiment, frequently preparing his gallon jug of slacked lime at his room in Gold street, and carrying it on foot to the mill, a distance of three miles.

The effect, however, of the lime upon the gum, after a time proved to be too powerful, and it was abandoned.

He shortly after this discovered what has since been known as the acid gas process. In attempting to ornament a piece of gum-elastic drapery, which was made by boiling in lime with metal bronze, and not producing the desired effect, he afterwards applied nitric acid for the purpose of removing the bronze, in doing which, the specimen was discolored, and thrown away as useless. In reflecting on this circumstance some days afterwards, it occurred to the writer that he had not sufficiently examined the unusual appearance of the article. He was fortunate in finding it, and followed up the suggestion made by the circumstance, until, in the course of a few months, he was able to make, by this process of tanning, as elegant specimens as have ever been made since.

This improvement attracted much attention from eminent chemists, and the public institutions of the country. The certificates of some of these individuals, and the inscriptions

upon medals that were awarded to the inventor at that time, serve to show the estimation in which the improvement was held by them. These will be found quoted among the testimonials.

Those, however, who have had experience with the progress of inventions, and of the hindrances in the way of bringing them into notice, will be sensible of the wide difference there is between the theoretic approbation of an invention by the public, and the substantial aid which is necessary to make a practical demonstration of its utility.

The prospect of success with this improvement, enabled the inventor to make arrangements with an individual in New York,* to furnish the capital for manufacturing on joint account. Accordingly a steam power was rented in Bank street for this purpose. The inventor proceeded to Washington and procured letters patent for the invention, which was highly appreciated by the officers of the various departments of Government, from whom he received much encouragement.

This process, however, did not change the character of the gum throughout, as it was then supposed to do by himself and others; and in consequence of an occurrence hereafter referred to, it has not received the attention to which it is really entitled. In consequence of some modifications in the method of operating it, in connection with the inodorous fabrics, it has also gained increased importance in the mind of the inventor, and he has no doubt that when the subject is understood and duly appreciated, it will be ranked next in importance to the vulcanizing improvements.

For this invention letters patent were granted him in 1837—and a patent was granted to Thomas Hancock, in England, for the same thing in 183–.

While secretly operating this process, before having applied for letters patent, the inventor came near being suffocated by generating a large quantity of gas in a close room; he, however, escaped with a course of fever, during which he was attended

* Mr. William Ballard.

by Dr. Joseph Bradshaw, an eminent medical practitioner, and a native of England. He had previously formed an acquaintance with this gentleman, who took a deep interest in the improvement of gum-elastic, and frequently inquired after the success of the experiments with it. Specimens made by this process attracted his particular attention at this time, and he expressed to the inventor his intention of visiting his friends in England soon after, and kindly offered to take specimens to the manufacturers there, with a view to negociations for him. At the time he sailed, in the month of , 1836, the inventor made up for him a small assortment of specimens of gum-elastic drapery, which he took directly to the house of ., England.

These specimens were much admired by this house as novelties, and assurances were given to the Doctor, that if the invention proved to be a useful one, a liberal compensation for it would be made by them. The English patent was taken out by Mr. Hancock, without any communication with the inventor. This may be correct according to the English patent laws, but is not according to the ideas of justice entertained by the inventor. The acknowledgment was however given, which is implied in the legal preface attached to English patents, when they are obtained for improvements introduced from another country.*

The improvement gradually obtained the confidence of the public in the United States, and became the subject of newspaper paragraphs throughout the country.

During the fall of 1836, he also obtained medals at several fairs, one of them being for the application of India rubber to the art of printing.

Success now seemed certain, and he was prepared to demonstrate, by the manufacture of the goods, the utility of the improvements of which specimens had only yet been produced.

The manufacture was continued in Bank street during the winter of 1836-37. In the meantime, a large factory with

* By information obtained from a foreigner.

machinery, situated on Staten Island, was engaged by the individual who had undertaken to aid in the manufacture. This factory had been built by a corporation in New York, and occupied for the manufacture of India rubber for about a year, but was now abandoned. A large warehouse in Broadway was also engaged by him, in anticipation of the sale of the goods.

But a new misfortune awaited the inventor. The individual above alluded to, who had engaged to furnish the means to conduct the manufacture, was overwhelmed in the disasters which befel the mercantile community in 1836; he was left without ability to proceed; and this inability was erroneously attributed to the unfortunate business of India rubber, and want of merit in the improvement, instead of the true cause.

The inventor was again left without resources or means of subsistence.. The extreme difficulty of obtaining such means of subsistence for a family in a large city, where one's fortunes are known to be bad, may easily be imagined. The following incident may illustrate the manner in which they are sometimes unexpectedly relieved by a kind Providence. He had put in his pocket a small article much valued, and sallied forth in the morning for the purpose of obtaining with it food for the day. Before reaching the pawnbroker's shop he met a creditor, from whom he expected to receive sharp, if not bitter reproaches. His astonishment was so great that he could hardly trust his hearing, when he accosted him with the inquiry, what he could do for him. On being satisfied that no insult was intended, he replied, without telling him that he was in search of food, that the sum of fifteen dollars would greatly oblige him. It was instantly handed to him, and the article which had been designed for the pawnbroker, remained in the hands of the owner, to relieve a greater necessity on a future occasion. He was now, for some time, at the mercy of the pawnbroker, every article that could be made available was pledged, until he was relieved, for the time, by the loan of one hundred dollars from a friend.*

* James Deforest, Esq.

In order to avail himself of the use of some furniture in possession of a younger brother, as well as his services in the factory, he assumed the support of his family, and placed them with his own in a cottage connected with the establishment on Staten Island. Having access to the machinery, he succeeded in making a few articles to sell, for the supply of their immediate wants.

An attempt was made to draw the attention of the shareholders of this establishment to the new improvement, in order that they might revive their business, and also benefit the inventor. But the failure of their attempts to manufacture the gum had been so disastrous, that during the six months he was there he was never able to get an individual to the factory, to look at the invention, or even to look after the premises, so completely were they abandoned.

It is, perhaps, worthy of remark, that during the first years of his experiments, until after he had discovered the heating or vulcanizing process, and became certain that he had attained his object, he made it an invariable practice to test the value of the various experiments, by wearing some article of apparel made from the material, that he might as soon as possible arrive at correct conclusions respecting them ; the wearing of gum-elastic about the person being one of the severest tests to which it can be put.

An anecdote may be related which exhibits in its true light, not only the opinion of the public as relates to the enthusiasm of the inventor, but also his poverty.

A gentleman being inquired of how he might be recognized, said, "If you meet a man who has on an India rubber cap, stock, coat, vest, and shoes, with an India rubber money purse, without a cent of money in it, that is he."

Late in the summer of 1836 he succeeded in obtaining a small loan from a friend ; collected a handful of his best specimens and went to Roxbury, Massachusetts, for the purpose of ascertaining what might be done there. He was kindly received there by some gentlemen who were formerly his customers in

the hardware line, and Mr. Henry Willis, with whom an intimate acquaintance had been formed during his apprenticeship in Philadelphia, and who generously gave him facilities. His plans were also materially forwarded by the sympathy and kindness of Mr. John Haskins and Mr. E. M. Chaffee.

Boston and the country for twenty miles round, was then suffering from the severe losses incurred through the manufacture and speculations in this business. In 1834, such was the mania upon the subject, that it was generally considered in this vicinity, a want of common sagacity for any one not to own more or less India rubber stock. It was the all prevailing topic of excitement, and if he could have brought his improvement to Boston in season, as the agent of the Roxbury company assured him, before he commenced his experiments, he would unquestionably have realized a large sum for it. But now, the public mind was completely paralysed and disgusted with the subject, and it was of importance to the credit of any man in business, that he should be known not to have any thing to do with it; and much more to his credit, if he could show that he had never engaged in the speculation. He however met with several gentlemen of independence, who, notwithstanding their heavy losses in the business, from pride of opinion on the subject, were very desirous to see the business rise again. Through these persons he brought his specimens to the notice of the public, and obtained access to the use of the famous Roxbury machinery, by which he was able *without the use of turpentine*, to demonstrate the importance of his invention.

The invention of this machine resuscitated the Roxbury Company, and caused the stock to advance to par, after nearly the whole capital of the company had been sunk in fruitless attempts to manufacture the goods with solvents. It was supposed that the solvents being dispensed with, the difficulties of the manufacture, occasioned by the adhesiveness and decomposition of the goods, would be quite surmounted, and that the gum would be at least as good as in its native state.

It was subsequently ascertained by the company that their

embarrassments were not owing to the solvents that were used in the manufacture, but to adhesiveness being an inherent property of the gum. The stock again declined, until the manufacture was completely abandoned by the company, about the time the writer first went to Roxbury.

Several years subsequent to this time, this machine, with Mr. Chaffee's patent for it, was purchased by the writer. Machinery of this description, for manufacturing without solvents, has now become of great importance, and is almost indispensable for the economical and successful manufacture of the heavier kinds of goods made by the vulcanizing process.

In the winter of 1837-38, the inventor re-commenced the manufacture of shoes with better success than that which attended his experiments at New Haven. He then invented a new method of constructing shoes, for which a patent was granted him, which patent was disposed of in connection with a license for curing them by the acid gas process.*

In the summer of 1838 two licenses were disposed of, one for piano-forte covers and table-cloths,† another for carriage-cloths;‡ both of these were for the use of the acid gas in connection with the solarizing process. The origin of the first named process has been stated, that of the latter may here be noticed.

In the summer of 1838 he became acquainted with Mr. Nathaniel Hayward, of Woburn, Mass., who had been employed as the foreman of the Eagle Company at Woburn, where he had made use of sulphur by impregnating the solvent with it. It was through him that the writer received the first knowledge of the use of sulphur as a drier of gum-elastic.

Mr. Hayward was left in possession of the factory, which was

* This patent and license were purchased by J. W. Clark, Esq., of Boston, and Charles Jackson, Esq., of Providence, who established a manufactory at Providence, where the business has been extensively and successfully prosecuted until the present time. under the firm of Isaac Hartshorn and Company.

† Messrs. Luke Baldwin and John Haskins, who established a factory at Lynn, Mass., for the manufacture of cloths and table-covers. This establishment was afterwards removed to Roxbury, where it was continued until Mr John Haskins engaged in the first manufacture of letter bands and elastics, by the vulcanizing process, under a license from the inventor.

‡ This was purchased by Mr. Luther Clark, of Northampton, Mass., where the manufacture was established, and discontinued about a year afterwards.

abandoned by the Eagle Company. Soon after this it was occupied by the writer, who employed him for the purpose of manufacturing life-preservers and other articles, by the acid gas and solarizing processes. About this time the writer purchased the claim of combining sulphur with India rubber, of Mr. Hayward, for which a patent was taken out February 24, 1839. It should be remarked that this claim was for the use of sulphur, and not for the heating or vulcanizing process, subsequently discovered by the writer.

One remarkable fact relating to the use of sulphur with a solvent deserves to be noticed, and also the manner in which it was ascertained that its use by mixing the flour of sulphur with the gum, without a solvent, has a very different effect from that which is obtained by its use with a solvent. When a minute portion of it is put into the solvent, or when the solvent is impregnated with a quantity to the gallon so small as hardly to be appreciated in weight, the gum which is dissolved with it and spread thin upon cloth, when exposed to the sun for a single day, will dry up so that it may be rubbed off the cloth in a dry powder, whereas the sulphur in large quantity, or as much as half a pound to the pound of gum, (which either has or has not been dissolved,) may be mixed with it, and it will not be scorched in solarizing, or injured by exposure to the sun afterwards, for a great length of time.*

From having the use of the only machinery with which the gum was worked at that time without a solvent, the writer made his first experiments with sulphur in that way, by which means he ascertained the results peculiar to the different ways of using the materials. It was his discovery and observation of this peculiar result, that led the writer to continue his experiments with sulphur, and to purchase the patent of Mr. Hayward,† notwithstanding its use was not considered advantageous or practicable by the Eagle company, or other manufacturers. He

* These peculiar results, from the different methods of combining sulphur and gum-elastic, are considered worthy of notice, although neither of them are practiced by manufacturers at the present time.

† Taken out at the suggestion of the writer.

was, in fact, frequently cautioned by Mr. Hayward not to use it in the crude state, because its effects were so powerful when used in a minute quantity in the solvent. Mr. Chaffee had also tried it while with the Roxbury Company, and the effects were not deemed worthy of notice, either by that company or himself. At that time, previous to the introduction of the acid gas and vulcanizing process, the obnoxious odor of sulphur in the goods was an effectual barrier to their reception in the market.

Another effect yet more remarkable in the treatment of gum-elastic, is that of the sun's rays upon it. When combined with sulphur, and exposed to the action of the sun, either in hot weather or cold, it becomes solarized, or divested of its adhesive quality; whereas no other kind of light or heat has any similar effect, until the high degree of heat is applied to it, about 270°, which is used in vulcanizing.

By the sale of the licenses before referred to, the inventor realized a few thousand dollars, which relieved him from his immediate embarrassment. He had, beside, the prospect of being well compensated for his past labors and trials, and was now comfortably situated, with a pleasant home for his family. His aged parents, and two younger brothers, all of whose fortunes had continued to decline, at this time joined him. The prejudices of the public gave way, and his fortunes were altogether in the ascendant.

At this period he made many novel and useful applications of this substance: among other fancy articles, he had newspapers printed on the gum-elastic drapery; and the improvement, with its various applications, began to be highly appreciated.

The merit of the improvement was, in some respects, overrated. It was supposed by others, as well as himself, that a change was wrought throughout the mass of the goods acted upon by the acid gas, and that the whole body of the article was made better than the native gum. The surface of the goods really was so; and is always superior, even to that of heated or vulcanized gum-elastic, with the application of this process. The gum is not, however, changed far below the surface, but the

portion acted upon being very superior, and the interior equally as good as the native gum, the improvement, on the whole, gave satisfaction, and the inventor imagined that he had done all that could be done to improve the material. He therefore now entered, (as he thought,) upon a successful career for the future. A far different result, however, awaited him. While the invention, and the numerous applications of it were getting highly into favor with the public, he received an order from the Government for a considerable quantity of mail-bags. This fact was much known, and looked upon as a test of the utility of the improvement. If the mail-bags proved satisfactory, it was admitted that the invention would be completely successful.

They were being finished in the warm season, and were purposely exposed for inspection in his factory, which was much visited from motives of curiosity, but while he was absent a few weeks, they were discovered to be decomposing, and to be dropping off the handles.

The inventor had been recently in the habit of using chromes, white lead, and vermilion, and a variety of articles for the purpose of producing colors; some of which he used in the mail-bags, with the view of giving them a good leather color. These proved deleterious to the goods, as the manufacture was then conducted, and destroyed them.* The reputation of the acid gas process, upon which he wholly relied, had been theoretically established, and, it was supposed, fairly tested, previous to the decomposition of the mail-bags before alluded to. Since the true cause of the decomposition of the goods at that time has become known, it has been considered, as before, a real improvement, and is practiced in the manufacture in connection with the vulcanizing process, with great advantage. But at that time he relied too much upon its efficacy to change the character or properties of the gum, and to prevent the effects of other in-

* These articles are not injurious when mixed and vulcanized with India rubber, but rather serve to facilitate the process, and had it not been for this misfortune from the use of these articles in all human probability the vulcanizing process would never have been discovered.

gredients that are now known to cause fermentation or decomposition, when heat and sulphur are not used.

Being desirous to beautify the fabrics with a variety of colors, the writer used metallic and other colors indiscriminately for this purpose.

At this time, (intending to pursue the business as a manufacturer,) he commenced the manufacture of a variety of fancy articles, and several thousand life-preservers were made, which were sold and distributed through the country. These various articles were compounded with large quantities of white lead and other deleterious coloring matter, which caused them to decompose after the lapse of a short time, and thus that which he had represented as a useful discovery, and which was so in fact, was pronounced by the public to be a complete failure. Instead of realizing the large fortune which, by all acquainted with his prospects, was considered certain, his whole invention would not bring him a week's living. Again he saw those dear to him, together with his aged parents, stripped of the comforts with which they were surrounded. Every thing that he possessed was brought to the hammer for the discharge of private bills.

The inventor very soon became satisfied that the supposed failure of the invention was wholly in consequence of the coloring materials used, but it was at that time useless to affirm it, and he did not attempt to reverse the sentence of public opinion, because he was under the necessity of encountering the evils of the misfortune before he had an opportunity of making the real merits of the improvement known. The misfortune and disappointment of the writer by this occurrence was indeed serious. He was not only reduced to extreme poverty, with a large family to provide for; but, if he continued his experiments, he could no longer expect the countenance or sympathy of his friends or acquaintance, as he had already spent four years in fruitless attempts to make improvements in the manufacture that had proved so ruinous to the community, having, as was generally known, applied himself industriously to his experiments during the whole time, doing nothing else. It was generally

agreed that the man who could proceed further in a course of this sort, was fairly deserving of all the distress brought upon himself, beside being justly debarred the sympathy of others. And he was not unfrequently reminded that he could at any time improve his circumstances, by acting upon the advice of friends, to return to his former occupation of hardware. There was no longer any alternative for him, except to make choice of one of two ways—either to return to what others thought a respectable occupation, in order to support his family, or to subsist as he best could in his then embarrassed condition.

The earnings of himself and family in the manufacture, by the common methods, of some small articles for which there was yet some demand, and the forlorn resort of the friendless and the destitute,—the pawnbroker's shop,—were his chief dependence.

The parties before alluded to, to whom licenses had been sold for the acid gas process, were so much discouraged by these occurrences, that no application could be made to them for assistance.

The recollection of the losses that had been previously sustained, in the depreciation of India rubber stocks, was now revived afresh in the public mind, and it was useless to look to any individual in the community for funds to be used in this manufacture, so strong was the prejudice against it.

The shares of the numerous companies that had failed with total loss of their capital, were so widely distributed, that their failure was indeed a public calamity; and although the pecuniary interests of the public were in no way affected by the disappointment of the inventor in the failure of his experiments, yet the effect of their disaffection, in consequence of their former losses, manifested in their distrust of every thing connected with the subject, was not only the cause of much chagrin to him at the time, but was also the chief hinderance to the introduction of his subsequent improvements.

He was obliged, for the want of means, to discontinue manufacturing, and Mr. Hayward left his employment, and returned to the manufacture (on his own account) of various articles, after the method first practiced by the Roxbury com-

pany and himself, in which he continued until about a year after the discovery of the vulcanizing process, of which he afterwards became one of the licensees, and proprietor of a shoe establishment at Colchester, Conn.*

Frequent visits to the factory at Woburn became necessary, for the purpose of closing up and discontinuing the manufacturing operations at that place. The appeals of his friends were now presented with fair prospects in their favor, to persuade him to change his plans, and discontinue his experiments with the manufacture.

At this time, as well as on many former occasions, if the improvement sought for had been one connected with machinery, or one, the prosecution of which depended upon the art of any human being, or upon any amount of capital beyond a few sixpences at a time, necessity would have compelled him to yield; but so long as these could be obtained or hoped for, experiment could be continued, and the discovery made, as it was, in the most humble sphere.

The inventor now applied himself alone, with unabated ardor and diligence, to detect the cause of his misfortune, and, if possible, to retrieve the lost reputation of his invention; and, as had happened on former occasions, he had hardly time enough to realize the extent of his embarrassment, before he became intently engaged with another experiment, and his mind buoyant with new hopes and expectations; which, as it afterwards proved, were to be, for this time at least, more than realized.

While on one of the visits above alluded to, at the factory at Woburn, and at the dwelling where he stopped whenever he visited the manufactory at Woburn, the inventor made some experiments to ascertain the effect of heat upon the same compound that had decomposed in the mail-bags and other articles. He was surprised to find that the specimen, being carelessly brought in contact with a hot stove, charred like leather. He endeavored to call the attention of his brother, as well as some other individuals who were

* Under the firm of N. Hayward & Co.

present, and who were acquainted with the manufacture of gum-elastic, to this effect, as remarkable, and unlike any before known, since gum-elastic always melted when exposed to a high degree of heat. The occurrence did not at the time appear to them to be worthy of notice; it was considered as one of the frequent appeals that he was in the habit of making, in behalf of some new experiment.

He however directly inferred that if the process of charring could be stopped at the right point, it might divest the gum of its native adhesiveness throughout, which would make it better than the native gum. Upon further trial with heat, he was further convinced of the correctness of this inference by finding that India rubber could not be melted in boiling sulphur at any heat ever so great, but always charred.

He made another trial of heating a similar fabric, before an open fire. The same effect, that of charring the gum, followed; but there were further and very satisfactory indications of ultimate success, in producing the desired result, as upon the edge of the charred portions of the fabric, there appeared a line, or border, that was not charred, but perfectly cured.

He now removed with his family to Lynn, in order that he might have access to the steam power of Messrs. Baldwin & Haskins, for the purpose of trying experiments in vulcanizing by steam.

A few weeks after, he removed from Lynn to Woburn, where he now pursued his inquiries and experiments for some months quite alone, until the desired result was obtained. On ascertaining to a certainty that he had found the object of his search, and much more, and that the new substance was proof against cold, and the solvents of native gum, he felt himself amply repaid for the past, and quite indifferent as to the trials of the future.

The facts have been stated precisely as they occurred in reference to the discovery of the acid gas, as well as the vulcanizing process. The incidents attending the discovery of both have a strong resemblance, so much so, they may be considered parallel cases. It being now known that the results of the vul-

canizing process are produced by means, and in a manner, which would not have been anticipated from any reasoning on the subject, and that they have not yet been satisfactorily accounted for, it has been sometimes asked how the inventor came to make the discovery. The answer has already been given. It may be added, that he was many years seeking to accomplish this object, and that he allowed nothing to escape his notice that related to the subject. Like the falling of an apple, it was suggestive of an important fact to one whose mind was previously prepared to draw an inference from any occurrence which might favor the object of his research. While the inventor admits that these discoveries were not the result of *scientific* chemical investigations, he is not willing to admit that they were the result of what is commonly termed accident; he claims them to be the result of the closest application and observation.

The discoloring and charring of the specimens proved nothing, and discovered nothing of value, but quite the contrary; for in the first instance, as stated of the acid gas improvement, the specimen acted upon was thrown away as worthless, and left for some time; in the latter instance, the specimen that was charred was in like manner disregarded by others.

It may, therefore, be considered as one of those cases where the leading of the Creator providentially aids his creatures by what are termed accidents, to attain those things which are not attainable by the powers of reasoning he has conferred on them.

The discovery was now made, which, at the present day, is generally regarded as one of the most important improvements of the age, and justly so, when considered in connection with all the other improvements which are constantly being made from it, and depending upon the extraordinary properties of this article for their utility. It might, therefore, have been supposed that the embarrassments of the inventor would be at an end, and that the attention of the public would easily be drawn to the subject. This, however, was not the case. He had yet to wait two years in the most trying circumstances, before he could convince *any one* that a valuable discovery had been made.

It was certain that nothing could be done to restore the confidence of the public, in the vicinity of Boston, or to induce them to establish the business for a long time to come, and it would have been useless to visit any other part of the country for this purpose, even if he had had the means, without specimens large enough to be used, so as to prove the utility of the invention. There was, therefore, no alternative but to make such efforts as it was in his power to make to accomplish this object, in order to effect a change of place and circumstances.

It had been the design of the inventor, previous to the disappointment which attended the acid gas process, to introduce it into Europe as soon as practicable; and arrangements for this purpose were in progress, when proposals highly advantageous were made to him by the extensive manufacturing house of Messrs. Rattier & Guibal, for the introduction of the acid gas improvement into France.

In reply, they were informed that newly discovered improvements had been made, and that as soon as they were sufficiently advanced for exhibition, the writer would avail himself of these proposals. The prosperous condition of the manufacture of gum-elastic in other countries, so far as it was known, was a great encouragement to proceed, and stimulated his efforts to obtain specimens where he then was. Those which had already been made were of small size, and were in appearance like samples of the common India rubber. The confident assurances which the inventor expressed, were also such as had been made in relation to successive improvements during a period of several years, but which had resulted only in disappointment. It was, therefore, unreasonable to expect those with whom he was conversant to attach much importance to his views of the case, although they might give him credit for sincerity. The great difficulty now was to bring the minds of others to appreciate the subject as he did himself. The most that could be hoped for in the community where he then resided, was to get the improvement so far advanced, as to be able to present it in foreign countries, or in some other section of his own country.

The narration of a few incidents will give a brief but correct idea of the discouragements, of which there was, during those two years, a constant repetition in one form or other.

During the winter of 1839—40, a year after the writer was fully satisfied of the real value of his discovery, the greatest discouragements were met with.

During one of those long and severe snow-storms, which in New England sometimes occur, when even those who are blessed with health are confined within doors, he found that his family were left without food or fuel. His feelings were, that the face of nature was a fit emblem of his condition—cold and cheerless; but the recollection of a kind greeting received some time previous from an individual who resided some miles distant, and nearly a stranger, induced him, enfeebled by illness, to make the attempt to reach his house through the storm. After being by turns exhausted by walking against the driving snow, and rested upon its drifts, he reached the dwelling of this individual,* and stated to him briefly his condition, and the hopes he entertained of success from his discovery, if he should ever be able to convince others of the facts relating to it. He was cordially received, and not only supplied with a sum adequate to his immediate wants, but also furnished with facilities for continuing his experiments on a small scale.

The greater part of these facilities were applied during the winter in the manufacture of a set of military equipments, for specimens, with the intention of vulcanizing them as soon as an apparatus could be obtained for the purpose. Long before there was an opportunity of doing this, he found that the composition of the goods had so fermented that they could not be vulcanized. This was a result which it is now known will commonly occur, when gum-elastic is worked with a solvent, and compounded with lead and sulphur, unless it is vulcanized soon after it is manufactured. Thus he had lost the labors of the winter without effecting the object of obtaining the specimens

* O. B. Coolidge, Esq., Woburn, Mass , to whom a tribute of gratitude is due for the timely relief afforded.

he desired. Without them it was certain that nothing could be done to restore the confidence of the public, in the vicinity of Boston, or to induce them to establish the business for a long time to come, and it would have been useless to visit any other part of the country for this purpose, even if he had had the means, without specimens large enough to test the utility of the invention.

There was, therefore, no alternative but to continue his efforts to obtain specimens that would satisfy other minds, before he could hope to effect a change in his circumstances by a change of place; and it seemed absolutely necessary that these specimens should be such as might be tested by actual service. Like iron or steel, the quality of gum-elastic could not then, and cannot even now, be known by the appearance of its surface.

Those which had already been made were of small size, and were in appearance like samples of the common India rubber. The confident assurances which the inventor expressed, were also such as had been made in relation to other supposed improvements during a period of several years, but which had resulted only in disappointment. It was, therefore, unreasonable to expect those with whom he was conversant, to attach much importance to his views of the case, although they might give him credit for sincerity. The great difficulty now was to bring the minds of others to appreciate the subject as he did himself. The most, therefore, that could be hoped for in the community where he then resided, was to get the improvement so far advanced, as to be able to present it in foreign countries, or in some other section of his own country.*

* The prosperous condition of the manufacture of the native gum in other countries, was a great encouragement to proceed, and stimulated his efforts to obtain specimens where he then was.

It had been the design of the inventor, previous to the disappointment which attended the acid gas process, to introduce that process into Europe as soon as practicable: and arrangements for this purpose were in progress, when proposals highly advantageous were made to him by the extensive manufacturing house of Messrs. Rattier & Guibal, Paris, for the introduction of that improvement into France.

These proposals were made through Mr. Wm. B. Draper, of New York, who had for a long time resided, as a merchant, in Paris, and through him the reply was made in 1840, that the writer had discovered the heating or vulcanizing process, which would probably supersede the acid gas improvement, and would delay his visit to Paris.

Ten years subsequent have been devoted by the inventor to perfecting the vulcanizing process, and various improvements growing out of it, having it in view to introduce them into Europe when perfected.

That such indifference to this discovery, and many incidents attending it, could have existed in an intelligent and benevolent community, can only be accounted for by existing circumstances in that community. The great losses that had been sustained in the manufacture of gum-elastic ; the length of time the inventor had spent in what appeared to them to be entirely fruitless efforts to accomplish any thing with it ; added to his recent misfortunes and disappointments, all conspired, with his utter destitution, to produce a state of things as unfavorable to the promulgation of the discovery as can well be imagined.

He, however, felt in duty bound to beg in earnest, if need be, sooner than that the discovery should be lost to the world and to himself. That there was real danger of such loss, subsequent events abundantly prove. In the event of the writer's death, it could hardly be expected that his theory, which he afterwards found it so difficult to establish, could survive him. The invention was fully appreciated by him at that time, and was considered as valuable as it now proves to be. His inability to convince others of the truth of his assertions, or to bring them to comprehend the importance of the subject, caused intense anxiety as to the results, and produced a state of mind such as could have been ill endured, but for the excitement caused by efforts to surmount the obstacles he met with.

Want of sympathy, want of means to go forward with experiments, or even to provide sustenance from day to day for those dependent upon him, only increased the solicitude consequent upon the state of suspense as to the result of those efforts.

How he subsisted at this period, charity alone can tell, for it is as well to call things by their right names, and it is little else than charity, when the lender looks upon what he parts with as a gift. The pawning or selling some relic of better days, or some article of necessity, was a frequent expedient. His library had long since disappeared, but shortly after the discovery of this process, he collected and sold at auction the school books of his children, which brought him the trifling sum of five dollars; small as the amount was, it enabled him to proceed. At

this step he did not hesitate. The occasion, and the certainty of success, warranted the measure, which, in other circumstances, would have been sacrilege. The inventor had now grounds of assurance, which had never existed with regard to previous improvements.

The discovery was made in winter, and the specimens did not stiffen by cold. Summer returned, and they were not softened by heat. There could be no danger on this score, as they were made by a heat of two hundred and seventy degrees. The next thing of importance to be done, was to manufacture specimens of sufficient size to satisfy others of the importance of the invention by a trial of the goods. He was not, at first, aware of the difficulty that existed in the way of operating the process on a large scale. The specimens which he had thus far produced, were from the thinner sort of fabrics, which could be heated before an open fire. To heat a specimen of any considerable size or thickness in this way, proved to be impracticable, on account of the blistering of the gum. This difficulty subsequently caused great loss in the establishment of the manufacture by the various licensees.

In the course of the spring of 1839 he had succeeded in manufacturing some specimens tolerably perfect, and heating them before an open fire with the brushwood which the kindness of his neighbors allowed him to gather in the field, not being able during that summer to supply himself with more substantial fuel. Upon the exhibition of these specimens, and the earnestness of his appeals, some individuals were induced to assist him in building a brick oven, about six feet square, and also to manufacture some full pieces of the fabric. These were made by the machinery for the liquid gum, so that before they could be finished and heated, (the weather being warm,) the goods fermented, and they could not be vulcanized. This is a peculiarity of the vulcanizing process, remarked upon under the head of Dissolving, page . In this way the capital, which had been provided for this express purpose, three times in succession, was exhausted. The cause of fermentation not being known,

the effort to obtain larger specimens was at last relinquished, and he was compelled to take with him to New York those samples only which had been heated before an open fire in his dwelling. With these specimens he now endeavored to get to New York, having no hope of being listened to where he then was.

He had the assurance from an individual formerly in his employment, that on coming to Boston he would lend him fifty dollars, whereby his family could be maintained in his absence, and his expenses paid to New York. Arriving in Boston he was disappointed in this. He remained at a hotel from Monday until Saturday, hoping to obtain from some source the sum required. He at last applied where he had reason to expect it, for the sum of five dollars, with which he might return to his family; this was refused. At night his bill at the hotel was presented. Mortified and chagrined, he walked, meditating on his condition until late at night. He strayed into East Cambridge, and stopped at the house of a friend, who received him kindly and made him comfortable for the night. Early next morning he walked ten miles to his home, and was met at the door by one of the family, saying that his youngest boy, two years of age, who was in perfect health when he left home, was then dying. He thanked God for being turned back to the rescue of his family, for they had already been denied the subsistence promised by a dealer when he left.

The inventor then represented, by letter, the situation of his family, to a gentleman in Boston, a sincere friend, by whom he was confident that he could not be refused, and was not. He received from him the sum of seven dollars, out of regard, as he said, for his family, with a severe reprimand for himself for not turning his attention to some occupation that would support them. A stranger to the inventor, who happened to be at his friend's office, upon the receipt of his letter, forwarded to him a barrel of flour, which was indeed a timely relief and source of heartfelt gratitude.

He next addressed a letter to a relation in a distant part of

the country.* From him he received the sum of fifty dollars. This enabled him to get to New York, and to lay the subject before Mr. William Rider, a gentleman to whom he was introduced for the first time on his arrival there. An arrangement was soon made, by which Mr. Rider engaged to furnish capital to conduct the manufacture on joint account.

To the firmness and perseverance of Mr. William Rider, together with the skill and assiduity of his brother, Mr. Emory Rider, under a series of obstacles which this new manufacture encountered for several years, more than to the amount of the pecuniary aid rendered, the inventor feels indebted for a share of his success. From him he received a sufficient amount of funds for the comfort of his family, and sufficient to enable him to proceed, in a small way, with his experiments. Thus he continued for about a year, when the failure of his friend again left him without resources. He had, however, made some advance towards demonstrating the utility of his improvements, although he found it nearly impossible to get over the difficulties which he met with in the way of heating the goods with uniformity.

In the fall of 1841, before the failure of Mr. Rider, the inventor commenced operations in Springfield, Mass., having a short time previously succeeded in manufacturing some few yards of the elastic compound in sheets, and in heating them uniformly. This was done by passing them through a heated cast-iron trough, represented in the drawing, plate . This was the first successful operation of vulcanizing. At this time, also, he invented the shirred or corrugated goods, which have since been so famous, both on account of their intrinsic merit and on account of the numerous suits at law of which they have been the subject. Having shirred some elegant ribbons, they attracted the notice of a brother-in-law,* an extensive woolen manufacturer, and through him, the notice of the public. By the aid and kindness of this individual, who, for a time, furnished the means to conduct the manufacture, the inventor was enabled gradually

* William Deforest, Esq.

to proceed with his improvements. While at this place he was again thrown into prison for debt, which influenced him to avail himself of a release under the odious bankrupt law, about ten days before its repeal. This law he had always opposed, and firmly resolved not to accept of any of the advantages it offered, but the provocation, in this instance, was such that his resolution gave way; and, as things terminated, he has never had cause to regret his change of purpose, since, very shortly after this, his invention began to be appreciated; and, together with the success of the shirred goods before alluded to, enabled him to do justice to his creditors, notwithstanding his discharge in bankruptcy. Since that time to the present, he has had no occasion to complain of hard fortune, having continued his experiments and improvements according to the plan specified in another chapter, appropriating the receipts from his invention as they have accrued, to the purposes there stated. These means have been almost as inadequate for the object in view, as those which he formerly had were for the comfort of himself and family, and for his experiments before his success in the chief discovery. The want of pecuniary facilities has caused much delay in his course, which undoubtedly has had the effect to make the whole system much more complete than it would have been if he had possessed ample means. Although sometimes disheartened by the apparent loss of time from these hindrances, the inventor has, on the whole, good reason to be reconciled to these temporary delays, being well aware that the law of necessity in one form or other, is the only one under which invention will thrive or accomplish much. Millions might have been spent without effecting any thing in comparison with what has been done. Money is indispensable for the perfecting of improvements, but it is trial and necessity chiefly that are effectual in bringing to light things that are hidden; in other words, however indispensable money may be to carry out an enterprise, or perfect the improvements of an inventor, it will avail but little in bringing to light that which is unknown, especially where the subject cannot be approached by any known laws of science.

In this case, at least, it has been necessity, caused by the desire to obtain the means of discharging liabilities, and moral as well as pecuniary obligations, with the ambition of making these inventions worthy of this age of improvements, that has stimulated the inventor to proceed, step by step, to the completion of his plan.

CHAPTER VIII.

NATURE OF THE DISCOVERY.

The sole object sought after by numerous experimenters. The success of the author. The method of vulcanizing. Remarkable and very useful properties developed by the process. Availability and supply of the raw material.

As early as the year 1800, wherever the properties of India rubber became known and appreciated, it became a subject of much inquiry and experiment, to ascertain if there was any way by which it could be dissolved, and afterwards restored to its original state. This was the ultimatum sought after, by great numbers who occupied themselves in experiments with it, especially those of the medical profession, as well as by the writer in all his early experiments. It was not thought of or expected, (certainly not by the writer,) materially to improve upon the original good qualities of the gum. The object of the experiments was limited to the restoring of it to its original state, but even this was almost despaired of; hardly an approach to that effect could be made except with ether as a solvent, which was too expensive for any practical purpose. The success of the inventor, in imparting to gum-elastic new and valuable properties, and at the same time retaining all the useful qualities it possessed before, has not ceased to be matter of surprise to mankind, wherever it has become known.

This substance, aside from the difficulty of managing it chemically, was in its native state as wonderful and mysterious as any in nature, and it is rendered yet more wonderful, by the change wrought in it by this discovery.

A more particular description of the new properties thereby imparted to it is given in the following chapter, but a few gen-

eral comparisons or illustrations in this place may serve to give some persons a more correct idea of the nature of the results produced by the discovery of the process of vulcanizing, or heating, as it was first called by the inventor.

The change wrought in the native gum by this process may with propriety be compared to that which is wrought in a perishable skin or hide, by the process of tanning, which converts it into a beautiful kid, or substantial leather; or to that by which the crude ore is changed, by the process of smelting, into valuable iron for man's use; or to that by which iron is changed by the well known process of baking with carbon, into steel. This latter comparison holds good, not only as to the results, but also as to the method, except that instead of carbon, sulphur is used in the baking process, treated of for vulcanizing the gum, which is penetrated by sulphur after it has taken the form of a gas, a high degree of heat being used in both cases. One remarkable fact is exhibited by this improvement, which is an apparent anomaly in chemistry. An article is obtained which is not dissolved without great difficulty, by the best known solvents of gum-elastic, which yet possesses all the valuable properties of the native gum, and many others that the native gum does not possess. It will be readily perceived, that the effect of this process is not simply the improvement of a substance; but it amounts, in fact, to the production of a *new material.* The durability imparted to gum-elastic by the heating or vulcanizing process, not only improves it for its own peculiar and legitimate uses, but also renders it a fit substitute for a variety of other substances where its use had not before been contemplated. It may, at first thought, appear absurd to compare the durability of an article like gum-elastic, with that of metal or wood, yet it will be found upon investigation, that in consequence of its resistance of corrosion and decay, it is, for certain purposes, far more durable than either of these, as has been found by actual trial. Nitric acid quickly destroys iron, brass, copper, &c. Potash destroys leather, and wood. Some fabrics are rendered unfit for use, by coming in contact with

grease, tar, &c., and others damaged, or destroyed, even by water; but none of these agents injure the fabrics, which are known under the name of the metallic, or "vulcanized fabrics." It has now been proved, by several years' experience in its use, that by this discovery, a substance is produced, possessing all the valuable properties of gum-elastic in the highest degree of perfection, without the imperfections pertaining to the native gum, which must have prevented gum-elastic ever being applied to many purposes of great utility, for which, by the removal of its objectionable qualities, it is now made available.

When a new material is in any way made available to the arts and manufactures, it is impossible to set bounds to its application, or to the extent of the benefits to be derived from it.

Where the supplies of the material are obtained, as is the case with the India rubber, from regions that for various reasons can never be extensively cultivated; where the spontaneous productions of nature are profuse, and where the inhabitants of such regions appear incapable of higher effort and enterprise than is required simply to gather those productions; there are good reasons for anticipating additional advantages from an improvement, other than mere usefulness in its application. The indirect advantages which are derived from it, in the extension of commerce, and advancement of the general, mutual interests of mankind, are many.

It would appear that some portions of the earth are designed, in the economy of Providence, to furnish these abundant supplies of nature's spontaneous productions, to be improved in civilized life, in countries where nature is less bounteous, and art is more prolific.

In view of the vast increase in the consumption of gum-elastic, the question is frequently asked, "can the supply be kept up?" The answer has already been given, and it may be further said that it appears to be so ordered, in the wisdom of Providence, that those things which are indispensable to the comfort and happiness of man, are most abundant and most easily obtained. The truth of this is exemplified in the abund-

ant supply of coal for fuel, of iron among the metals, for tools and implements, and in the abundance and cheapness of glass ware. What is also remarkable is, that it appears that various substitutes for things in use are frequently discovered just at the time when the articles become scarce; and what is yet more remarkable, the substitutes which are discovered often answer a better purpose than the article originally used.

This remark will apply particularly to coal, as a substitute for wood; to vegetable oils, gas, and lard oil, as substitutes for whale oil; and why may we not extend the comparison to gum-elastic, and say that by this discovery we have received a vegetable leather as a substitute, to some extent, for animal leather, gum-elastic vellum for parchment, and for certain uses at least, such as umbrellas, oil-silks, &c., a vegetable silk for that spun by insects?

N. B. A distinctive and singular feature in this discovery, and one that is deserving of special notice, is this, that heat, which is one of the two principal agents which produce the desired result, melts every kind of caoutchouc at a comparatively very low temperature. The heat of the sun's rays will melt them, while, with the presence of the other agent, that of sulphur, the great change is wrought in the caoutchouc, and the improvement is completed, at the high temperature of nearly 300°.

CHAPTER IX.

GOODYEAR'S HEATED OR VULCANIZED INDIA RUBBER.

Characteristics of the native gum. Goodyear's heated or vulcanized India rubber; its elasticity; pliability; durability; insolubility; unalterability; inadhesiveness; impermeability; plasticity; facility of printing, and of being ornamented by painting, bronzing, gilding, japanning, and mixing with colors; non-electric property; odor. Test of vulcanized and unvulcanized gum-elastic.

In order to have a correct understanding of what the improvement consists in, which is treated of in this work, as existing in such a variety of forms and aspects, it will be necessary to bear in mind, what are the properties and defects of the gum in its native state, as heretofore described under the head of Native Gum-elastic; and also that the utility of the numerous fabrics and applications of this improvement depends upon the change wrought in the gum by the vulcanizing process; that the cheapness of the production, and the durability of many of the articles, depends upon the mechanical improvement of the laminated fibrous fabrics.

A description of the method by which the change is wrought in the gum, and the causes which led to its accomplishment, have been heretofore given. The properties of the heated or vulcanized gum-elastic, will be better understood and appreciated, when contrasted with the defects and objections to the gum in its native state, which are these:—1st. It becomes rigid and inflexible in cold weather. 2d. It is softened and decomposed in the sun and hot weather. 3d. It is very soluble and quickly dissolved when brought in contact with any kind of grease, essential or common oils; and though more slowly, yet as surely dissolved by perspiration. 4th. It is in its nature so

very adhesive, that when any two surfaces are brought in contact, they become by slight pressure one mass, that cannot be separated. 5th. It loses its elasticity by continued tension, or constant use. 6th. It has a very unpleasant odor. It has been long and fully proved, that these objections and defects render the native gum unfit for general purposes, as almost every article is exposed to come in contact with some one or more of the destructive agents mentioned.

PROPERTIES OF HEATED OR VULCANIZED INDIA RUBBER.

1st. Elasticity.
2d. Pliability.
3d. Durability.
4th. Insolubility.
5th. Unalterability by climate, or artificial heat or cold.
6th. Inadhesiveness.
7th. Impermeability to air, gases, and liquids.
8th. Plasticity.
9th. Facility of receiving every style of printing.
10th. Facility of being ornamented by painting, bronzing, gilding, japanning, and mixing with colors.
11th. Non-electric quality.
12th. Odor.

1st. ELASTICITY.

This property of the native gum is improved and increased, in the metallic or vulcanized article, both as regards strength and continuance; besides, it is hereby made available in all climates, and in all circumstances, whereas the elasticity of the native gum is lost when frozen, or much exposed to the sun or great heat. The improvement in this respect becomes in-

valuable, even if it were confined to the single application of car-springs.

The elasticity of this article is commonly viewed only with regard to elasticity by tension, but the elasticity of it by compression is, perhaps, the most important of the two, as it is in this way that it is applied to car and carriage-springs, to buffers, and to springs for door-locks, &c.

2D. PLIABILITY.

The fabrics of this substance possess this property in the highest degree, not being affected, or made rigid, by the greatest degree of cold, whereas the native gum becomes so hard and inflexible in coarse fabrics and heavy articles, in a cold climate, as to be quite unmanageable and useless.

No other fabric is so completely flexible under all circumstances, not even common woven cloth, for the reason, that when cloth is wet and exposed to cold, it becomes frozen, whereas these fabrics repelling water, continue pliable.

3D. DURABILITY.

This substance has been found to remain unchanged by time, whether kept in a wet or dry state. This statement is confirmed by observation and experience during a period of several years. Neither is it known to be attacked by moth, or vermin of any kind. The reader may form a correct idea of the durability of this substance, when exposed to friction, from the durability of the soles of the overshoes in common use, upon which hardly an impression is made, by years of ordinary wear,

4TH. INSOLUBILITY.

It is not strictly true, as has been sometimes said, that this substance is absolutely insoluble, because it can be softened and even dissolved by powerful solvents of the gum, when heated and boiled, and it can be charred by being kept a long time in pure sulphuric or nitric acid; but its power of resistance of the solvents, and all other destructive chemical agents, is truly great. The most delicate of the fabrics made of this material may be brought in contact, or immersed with impunity, in such chemical liquids as sulphuric or nitric acid, sulphuric ether, oil of turpentine, or any of the essential oils. Or they may be boiled in potash, lime, chloride of lime, soap-suds, &c., by which ordeal, so far from being injured, they are rather improved. In other words, it is either improved, or remains uninjured, when exposed to destructive agents, that destroy other fabrics, and even wood, leather, and the metals, such as iron, copper, and brass.

5TH. UNALTERABILITY

BY CLIMATE AND ARTIFICIAL HEAT OR COLD.

Its endurance of artificial heat is very great, when compounded with particular reference to this quality, and with a larger proportion of sulphur than is ordinarily used, it will bear a heat of 300° Farenheit. If a higher degree of heat is applied, it chars, but does not melt. It may, therefore, be considered superfluous to say, that this substance will resist the heat of any climate; and as has been stated under the head of pliability, it remains soft and pliable in any degree of cold.

6TH. INADHESIVENESS.

The great adhesiveness of the native gum, after being manufactured and applied to use, was one of the chief objections to it.

The heated or vulcanized gum is entirely free from this objection, having all the dryness of leather or cloth, and that which forcibly illustrates its inadhesive property, is the fact that no way is yet found to unite it firmly, even when it is desired; and the art of making the fabrics adhere, after they are vulcanized, if one could be found, would be very valuable, since the fabrics might then be made up, and cemented by the purchaser, as well as the manufacturers.

The property of inadhesiveness involves the important quality of cleanliness, and facility of being cleaned when soiled. In the perfection of this quality it resembles glass.

7TH. IMPERMEABILITY

TO AIR GASES AND LIQUIDS.

This is a property of the native gum, which is fully retained in the vulcanized material, and in the "fabrics" generally. It is improved for containing or resisting water and liquids, as it is not softened by them like the native gum, but it cannot be stated that it is more impervious to air and the gases than the native gum.

8TH. PLASTICITY.

One of the properties of this material, which contributes primarily as much as any other to enhance its value to man-

kind, is its native adhesive properties and plastic nature, before being subjected to the process of vulcanizing. It is so very plastic, that the labor and expense of working it into almost any article, or form, becomes barely nominal, for which reason, when substituted for many other things, such as shoes, heavy harness, or leather trunks, where the leather has to be stitched to form the article, this material has a very great advantage on the score of economy. The facility with which it is thrown into any form, or moulded in any shape, is not surpassed by wax, or by lead, or any other of the soft metals. The parts of any article made of it, and of all the fabrics before being vulcanized, adhere upon the slightest touch, and upon slight pressure with hand tools, or the fingers even, the parts become one mass, so that the seams, without a stitch, become the strongest part of the article, for the reason that they are the thickest. The labor of manufacturing some plain articles, is often less than the pasting of paper would be. The reader may form an idea of the readiness with which it yields to the will of the operative, from the fact that one girl will make up twenty, and even more, pairs of shoes, or five coats, in one day.

9TH. FACILITY OF PRINTING IN EVERY STYLE.

It is printed by steel and copper-plates, in lithography, and with types, without requiring to be dampened like paper, and with a delicacy and perfection, which is said not to be equalled by the finest tissue or proof-paper.

10TH. FACILITY

OF BEING ORNAMENTED BY PAINTING, BRONZING, GILDING, JAPANNING, AND MIXING WITH COLORS.

It is printed in oil or block printing, with much greater facility than oilcloths, because it is softer, and it retains oil-painting

better than canvas, because it does not crack. It is bronzed and gilded as easily, and with the same effect, as wood or leather. It is japanned like leather, and forms a ground for japanned fabrics, that will not crack like the paint ground ordinarily used. It is mixed with any color that is desired in the manufacture, and the color remains unfading. When painted or ornamented with India rubber, mixed with colors in a liquid state, or mixed with colors when the gum is in a plastic state, the colors being incorporated with the material, become as indestructible as the fabric itself.

11TH. NON-ELECTRIC PROPERTY.

This substance is one of the best non-conductors of electricity, and it is but reasonable to suppose that advantages may be derived from some of the fabrics in connection with electric machines, on account of this property. An anecdote is told of a professor, who, having highly charged an electric machine while wearing India rubber shoes, and standing on the wire, upon taking them off, and resuming his position, he was convinced of their non-electric property, by being knocked down without them.

12TH. ODOR.

The vulcanized India rubber is, to a very great extent, freed from the natural offensive odor of the native gum. There has been heretofore so great an objection to all India rubber goods on account of their odor, and the removing of it has been a thing so difficult to accomplish, that the inventor does not choose to express an opinion with regard to the perfection of this improvement. He does not profess to have made even these fabrics unexceptionable to all persons, as it is clearly a matter of which no one can judge for another. To such persons as are particularly sensitive, and to all who have occasion to use either these or vulcanized gum-elastic fabrics, it may be a satisfaction to know that the articles are greatly improved by age, and that the odor of other things with which they are placed in contact is readily imparted to them, and when they are perfumed, or exposed to the fumes of burning coffee, or other aromatic substances, or if only placed in contact with them for a short time, the new odor is imparted and retained so as to predominate over that of the gum for a great length of time.

As it appears to be rendered certain that a great variety of articles manufactured from gum-elastic must come into general use, it is to be hoped that this objection is now so far removed that the goods will not be particularly objectionable on account of their odor. However this may be, it is certain that offensive odors become less objectionable where they necessarily exist, and that the sense of smell, like that of hearing, becomes insensible to those annoyances from which it cannot be protected. Although this rule is not without exception, it holds in most cases, and is strikingly exemplified in numerous occupations, among which might be instanced that of the druggist and tanner.

The patient endurance of the offensive odor of soiled bank notes and of leather, afford illustrations of the effect of necessity and habit.

Many articles which are in common use are by no means inodorous because they are supposed to be so. Wearing apparel or household stuff, particularly woolen, ever so neatly kept, would be found to be filled with odors offensive to any person unaccustomed to their use.

It is but reasonable to suppose that the objectionable odor which exists in gum-elastic, and which it has seemed impossible to overcome, will sooner or later be removed. Notwithstanding the constant failures to accomplish this object would almost lead one to despair of attaining it, and although nothing may yet have been done to warrant the expectation, the writer believes the thing which is so desirable and important will be attained. There is at least some ground for expecting this, from the fact that substances in general which are indispensable to the comfort and welfare of mankind, however imperfect they may be, are yet so made as not to offend the senses, and it may be hoped that such will be the result as relates to gum-elastic.

TEST OF VULCANIZED & UNVULCANIZED GUM-ELASTIC.

Camphene or turpentine, and also oil of sassafras, and all the essential oils, are as sure tests of the quality of gum-elastic, as nitric acid is of the genuineness of gold. As the native gum, and also the common manufacture of gum-elastic, have the same general appearance to those who are not acquainted with the manufacture and are not judges of the goods, as those that are vulcanized or solarized, these tests are necessary, not only to decide whether the goods are genuine, but also to ascertain whether those that are vulcanized or solarized are properly done. When these tests are applied to any fabric or cloth of native gum, they are rendered very adhesive, and so quickly, as to destroy any light fabric almost immediately; while they have no effect to make goods that are either well vulcanized or solarized

at all adhesive,—if it does so they are not well manufactured,—although all the fabrics, except the hard compounds, when long immersed in these oils, become swollen, yet they are not adhesive, and when the essential oil has evaporated, they again resume their original size.

CHAPTER X.

MANUFACTURE OF VULCANIZED GUM-ELASTIC.

Steam and water-power. Capital. Machinery. Cutting and washing machine. Compounding. Crushing and grinding machine. Warming machine. Spreading. Manufacture by dissolving. Manipulation. Heating. Solarization. Curing or tanning. Cleansing the goods. Peforating. Napping. Embossing. Japanning, bronzing, printing with type, copperplate, blocks, lithography, &c. Gilding. Plating. Cording. Thread cutting. Shirring. Moulding. Hollow-ware moulds. Concluding remarks.

The manufacture of India rubber goods by the process of heating, or vulcanizing, having become extensively known and practiced, especially in the United States, it is not supposed that more than a general description of the process, and the art of manufacturing the articles, will be considered interesting.

It is not believed that the interests of those licencees who have engaged in the manufacture in a legal and honorable way, by acknowledging the claims of the inventor, will be injuriously affected by the circulation of information on the subject, but that the legal advantages which they possess, and the skill already acquired, will be amply sufficient to guarantee to them the departments of the business in which they have respectively engaged.

Although no important fact has been withheld relating to the different processes in the manufacture, it is evident that no instructions or recipe can be given that will serve instead of experience. No branch of industry is more fascinating and interesting when learned, and no one can be more perplexing or intricate before skill is acquired in it, than this.

One of the first questions of importance with regard to any branch of industry in which numbers of operatives are employed, is, whether it is a healthful one.

In answer, it may be said, as relates to gum-elastic in general, that no occupation is more so. It is important, however, that

those who tend the dry heaters, or ovens, and those who cure with the acid gas, should be careful not to inhale the gases more than is absolutely necessary; those, also, who tend the grinders when lead is used, should take the precaution that is always necessary when this material is worked. The operatives, however, that work in these departments, form but a very small part of the number in any establishment, and for all others employed, it is more than ordinarily healthful.

POWER.

The same difference of opinion exists relating to the comparative advantages of water or steam power in this, as in other branches of manufacturing. There is, however, one advantage in favor of steam for this, which does not exist in some other manufactures, which is the use in it of steam extensively for other purposes besides the moving power, such as heating the callenders and grinders, vulcanizing and cleansing the goods, &c. It is, however, of much less account what kind of power is used than what amount.

So long as the limited way of operating is the only one believed in, and the only one called for by the wants of the community, it is necessarily the true way, and the wise one, for the time being; but it may be hoped that ere long, the merits of this growing manufacture will be so far appreciated as to bring to its aid, not only adequate machinery and power, but, also, corresponding capital. When this time arrives, a reduction will be made in the first cost of many of the articles, (the heavy ones in particular,) which will surprise the manufacturers themselves.

On this head the writer has ever felt a degree of solicitude and impatience, but must console himself by the reflection, that every extensive branch of industry has small beginnings; that spinning-wheels were used before cotton mills, and horses and carts before locomotives and rail cars.

CAPITAL.

It is often a matter of inquiry, what amount of capital is necessary to establish this manufacture. Owing to the plastic nature of the gum, and the simple construction of the machinery with which it may be worked, it can be conducted with a very small amount of capital. The Indian carries it on with the capital which nature affords him. Although the process of vulcanizing renders it somewhat more complicated, it may be prosecuted on a small scale to some advantage. Extensive water and steam power, with a large amount of capital, have been, however, recommended in other parts of this volume, as absolutely necessary for the most advantageous and profitable prosecution of this business. When the manufacture is favored with these advantages, the inducement to engage in it on a small scale will hardly exist. A more definite answer may, however, be made to the inquiry, upon which further estimates may be formed by any one, by taking the cost of a single set of machinery, the labor it performs, and the room it will occupy. The existing state of things is a suitable one upon which to make these estimates. A full set of machinery, such as is now employed for coating cloths, or manufacturing the fibrous fabrics, sufficient to turn off from one thousand to fifteen hundred yards per day, will cost, when put in working condition, about three thousand dollars. A basement, or a building of one story, thirty by twenty feet, is ample room for this purpose. Where the fabrics are made up into articles, (especially if a variety of articles are made up at the same establishment,) more room is necessary than is needed to make the same articles of other materials, on account of the adhesiveness of the fabrics. There are two advantages pertaining to this manufacture, that can hardly be said to exist in any other mechanical or manufacturing branches to the same extent. The first is, that there is not necessarily a particle of waste of materials; all the cuttings, and even the sweepings of the fac-

tories, are worked into gum-elastic felt for packing, shoe soles, &c. The other advantage is, that in this business the same tools are employed for its various branches, and the same operatives can be turned from making one description of articles to another, without delay or expense; and a female who is employed as a maker of garments one day, may become the next a good trunk-maker, harness, or shoe-maker.

MACHINERY.

The machinery employed in the manufacture of India rubber, since the first attempts to work it, has been subjected to variation and gradual improvement. Numerous expedients and divers machines were early tried for chopping, grinding, and spreading the gum, and also for flowing it in a liquid or semi-liquid state, which have been abandoned.

For many years the gum was only worked, after first being brought to a liquid, or semi-liquid state, by the solvents, such as turpentine or naphtha; and although this method is still used for the plated and fibrous fabrics and thin sheets of drapery, and for the finer and more delicate fabrics, it is otherwise wholly abandoned in America, where the vulcanizing process is used, and the machines now in common use, in which heat and pressure are employed, are substituted, for the purpose of crushing and spreading the gum.

It is now generally agreed by manufacturers in this business, that the machinery, or at least the principle of it, is perfect. It is hazardous to express an opinion, in this age of improvements, that any machinery or thing is perfect; but the best reason for believing that this machinery does not admit of further improvement in principle, is that no complaint is made of it. It is of the simplest kind, doing the work with great rapidity, although it requires great mechanical power, owing to the toughness and tenacity of the gum.

The representations in the drawing are deemed sufficient to give the reader a very correct idea of the manner in which the gum is reduced by grinding to the plastic state, and is afterwards spread by callenders.

CUTTING AND WASHING MACHINE.

This is performed with the machine represented by No. 1. This machine is the same as that used by paper-makers in cutting rags. It is simply a large vat, twelve feet long by four broad, and two feet deep; over this runs a shaft, upon which is a large drum or cylinder, about two feet in diameter, running on one side of the interior of the vat: this drum is furnished with shears or knives set in it, and other knives are set in the bottom of the vat. When revolving, this drum creates a current in the water under and between its shears. The bottles, shoes, or masses of gum, are first chopped with a hatchet, or cut with circular knives, into pieces of from one inch to three inches square. About five hundred pounds of the gum in this state is put into the vat at once, which is passed continuously between the shears of the revolving cutter and its bed, so that in the course of about four hours the whole mass is cut quite fine, and cleansed from bark, clay, &c., as far as possible, at which time it is ready for crushing or grinding.

By the use of this engine the scraps of the factories, which were formerly considered entirely worthless, are now worked into the valuable fabric described as felt, used for steam packing, shoe soles, &c. A large proportion of imported India rubber, especially of the India gum, was nearly useless, from the quantity of bark in it, until this engine came into use. The attention of the writer was first drawn to this engine by the following incident. On examining an India rubber belt, which was put into a paper-mill on trial, the proprietor complained to him that the India rubber which came from suspenders, mixed in the rags, damaged his

paper. Upon being further questioned, he brought a little parcel of the gum, about as fine as mustard seed, which was separated from the rags by the engine. The idea was suggested to the writer that the same operation would cut and cleanse India rubber. It was tried, and found completely successful, in all cases, as a labor-saving machine, and indispensable in the manufacture, when the gum is mixed with foreign substances.

COMPOUNDING.

It is important to observe, first of all, that the sulphur, lead, or other articles that are compounded with the gum, should be pure, and free from acid, otherwise the gases that are generated in heating, will cause the gum to blister; and when these substances, however pure, are compounded with dissolved gum, and especially with liquid cement, it should be used soon after it is mixed, and when the weather is very warm, or when it is kept in a warm room, within a day or two, otherwise it will ferment, and cannot be vulcanized. Ignorance of these particulars nearly prevented, for a considerable time, any practical applications of the discovery of vulcanizing being made by the inventor. Still greater caution is necessary when camphine or spirits of turpentine is used for dissolving the gum, for though it be obtained perfectly pure, yet if it is exposed to the atmosphere, or left to stand for a length of time, it becomes acid and unfit for dissolving gum-elastic. It was owing to this circumstance that the goods first manufactured in the United States were much worse, and the losses were much greater, than they otherwise would have been; and a want of proper care with regard to these various particulars, was the cause of many accidents, and much loss to those persons who first engaged in the manufacture of vulcanized gum-elastic, especially when dissolved gum was used.

Gum-elastic can be readily mixed or combined with almost

every other substance. It may be mixed with other gums, oils, coal-tar carbon, and with the earths and oxides, or pulverized metals and ores; and it can be combined with all fibrous substances, although it is not made like some of the gums, to adhere firmly to any smooth surface of metal or wood, or even of cloth. It is compounded in the manufacture with many of the above substances, for the purpose of obtaining particular advantages for special uses. Lampblack is often used to cause the gum to endure the effects of the sun and weather. Ground cork and other light substances are sometimes combined with the gum, to increase the bulk and make the articles light.

Earths are used as color, for cheapness, and to increase the weight of the fabric, as in the case of carpeting. Bitumen and resin are sometimes used to give the articles a finish or high lustre. Oxides of some of the metals are used in the manufacture; among these, white lead and litharge are commonly preferred. From two to four ounces of either of these metals to the pound of gum, cause the articles, and particularly those that are thick or massive, to be more readily changed, or vulcanized, and more completely, or with greater uniformity.

In the process of vulcanizing, the sulphur is applied through the medium of heat, in different ways, for the manufacture of different articles or fabrics for different uses. It is sometimes mixed with the gum in the process of crushing or grinding the gum, in the proportion of half an ounce of sulphur to the pound of gum; at other times it is dusted upon the goods in the form of flour of sulphur, before the goods are placed in the heater, or oven; this is commonly done when the mixture contains white lead, or when the coat of gum is thin and the goods light, in which cases the gum is more easily penetrated or impregnated with the sulphur, without its being mixed with the gum.

Another mode of applying the sulphur, or impregnating the gum with it, is that of generating the sulphurous gas in the oven or heater which contains the goods, or of introducing it into the oven after it is generated.

CRUSHING AND GRINDING MACHINE.

No. 2 represents the machine by which the gum is crushed, ground, and mixed with colors, and prepared for spreading upon cloth, rolling into sheets, or intermixing with fibre, for the laminated fabrics, called vellum, tissue, &c.

The callenders are hollow, and heated by steam to about 200° Fahrenheit. The gum, after having been chopped, cut and cleansed by the machine No. 1, and thoroughly dried in the loft of the manufactory, is passed between these callenders, and is thus reduced to a plastic state resembling dough in consistency. In this way from five to ten pounds are compounded and prepared for spreading, by one set of grinders at one time, in about half an hour. A number of these machines are required to supply one set of spreading callenders.

With suitable power and machinery, one hundred pounds would be crushed and prepared by one set of grinders, in the same length of time. A great proportion of this labor will be unnecessary when the gum can be obtained in a pure state, without being smoked, as described in the article entitled "Method of gathering the Gum."

Grinding the gum is the most tedious and expensive part of the manufacture of gum-elastic, which requires great mechanical power. It is want of adequate power and corresponding machinery for this purpose, and of that only, that the inventor is dissatisfied with the present state of the manufacture. The mammoth machine at Roxbury, built by Mr. Chaffee, which has been alluded to, and which weighs about thirty tons, is of the right class, but that has been comparatively inefficient, for the want of adequate power to work it.

For this reason, in part, and partly owing to its first cost, no other has ever been made of such dimensions, although money and time enough have been wasted, by the different manufacturers of gum-elastic, upon fragile machinery, which has failed

simply in consequence of its being too light, to have built many such sets of machinery as that alluded to.

But were a number of sets of such machinery employed with a thousand horse power, either of water or steam power, instead of from twenty to fifty horse power, which are now commonly employed, an immense saving would be made in this manufacture. With a number of sets of mammoth machinery, and adequate power, one complement of workmen, buildings, foremen, &c., would then accomplish in this department of the manufacture nearly the same amount of labor as is now accomplished by a great number of smaller powers and light machinery.

The great tenacity of the gum requires that the particles should be separated before it can be spread, and in order to do this when it is not dissolved, it becomes necessary to grind, or rather to knead it with callenders, as it cannot be ground in mills like granulated substances. Many attempts have been made to do this in the early stages of the manufacture, which were abandoned on account of the great power required. This is now done at most of the India rubber factories, by grinding or kneading about six or eight pounds at one time, until it is finished in the space of about twenty or thirty minutes. To conduct the manufacture to the best advantage, the machinery and power should be heavy enough to grind one hundred pounds in the same time.

Before the gum is spread, it is first placed in either a wooden or iron box, and warmed, and is passed from thence to the

WARMING MACHINE.

No. 3; which, in its construction, always resembles closely, if not exactly, the machines for crushing and grinding. This machine is used for warming up the gum, and for the purpose of spreading it, after being ground in No. 2. The cylinders are hollow, and heated by steam, like No. 2, to about 200° Fahren-

heit. This machine will warm the gum as fast as it is required to supply one spreading machine.

SPREADING.

This is performed with the machine represented by No. 4, by which the gum, after being mixed and prepared, is rolled into sheets, spread upon cloths, or combined with fibrous substances, by which means drapery, the laminated fabrics, &c., are formed.

The gum which is passed from the warming machine, No. 3, is placed between the first and second rolls from the top. The gum forms a sheet upon the second roll, and as it passes over, is pressed into the cloth, or cotton, which is passed between the third and fourth rolls. The fabric is wound upon a roll, in front of the machine, and connected with it; if the cloth is coated upon both sides, or if the fabric manufactured is drapery, or sheets of gum, they are rolled up in cloths, to prevent the surfaces from adhering together, until they can be worked up or vulcanized.

The average speed of this machine is such as to produce twelve hundred to fifteen hundred yards per day, covered with one coat of gum, and for some of the fabrics, two thousand yards per day.

These callenders, like Nos. 2 and 3, are hollow, and are heated to about 200°, Fahrenheit. In this part of the manufacture there is no delay, and when the supply of the gum is kept up by the grinders, the goods are turned off with a rapidity to satisfy those who are most impatient of delay.

The vast difference between the power of the two machines, that for crushing and grinding, and that for spreading the gum, and making the fabrics, has suggested to the inventor, that ultimately the plan might be adopted of preparing the gum at separate establishments, for the manufacturers of the fabrics and articles, with the same advantages that are obtained by the

preparation of tin plate or other metals for the manufacturer of those materials. Although the gum becomes, after being crushed, apparently as hard and unyielding as ever, it is, nevertheless, permanently prepared and subdued by the separation of the particles, for spreading, whenever it is warmed up. For these reasons it might be kept prepared and sold like other raw materials.

MANUFACTURE BY DISSOLVING.

This method is, at the present time, so far superseded by that of crushing and spreading with callenders heated by steam, as before described, that it is hardly considered worthy of notice; it will, however, be found that it has its own peculiar merit for particular purposes, for the manufacture of tissue, fine drapery, and gum-elastic sponge, and for cement it is indispensable; so that instead of going into disuse, it will be very extensively used in the manufacture of gum-elastic.

The gum is dissolved most readily by being first chopped fine, and being placed in iron or metal vessels, or vats, and adding camphene or turpentine enough to cover it, requiring usually about one quart to the pound of gum; this will bring the gum to the consistence of a very stiff paste when ground or kneaded; it is afterwards reduced, by adding camphene, to any desired consistency. In order to render it liquid enough to be used with the brush for cement, or to be spread with the knife, represented by machine No. 5, about a gallon of camphene is required.

Whenever it is desired to bring the gum to a liquid state, without the aid of machinery, it should first be chopped fine, and put into from three to four quarts of the solvent to a pound of gum, and stirred once in an hour or two, until it becomes dissolved.

It was the neglect to cut the gum in pieces small enough, and to add enough of the solvent at one time, that caused the art of

dissolving India rubber, for a long time after it was practiced to some extent, to be considered by many a secret, and a thing difficult to do, when it afterwards appeared that it was one of the simplest and easiest things possible, when it was proceeded with in the manner described.

The machine for spreading the gum in a liquid state, represented by No. , is simply what is called a straight-edge or knife, which applies the gum in exceedingly thin coats to the cloth, as it passes under it in the form of an endless belt. This was adopted as the best way, after various methods had been tried of flowing the gum, applying it with brushes, &c. The method now practiced enables the manufacturer to use the gum as a varnish or thin coating upon cloths, which, otherwise, it is almost impossible to do perfectly, or to any advantage, on account of the stringy quality of the liquid, and the sudden evaporation of the solvent.

Dissolved gum has more commonly been spread by callenders, such as represented by No. 6, worked when they are cold, or a little heated, and while the gum is in a semi-liquid state, or about the consistence of stiff dough; which, although it may be thoroughly dissolved, requires to be thoroughly ground or kneaded before it will spread evenly, or without what is termed by the workmen, crawling.

The cloth, when coated by this machine with successive layers of gum to form the thickness desired, is wound up on an open reel, when each coat is left to dry before another is applied; two or three coatings are commonly applied to form a waterproof cloth. The process is a slow one, making at the rate of about three hundred yards per day for one machine, but finer work can be done in this way than with the steam-heated callenders, and much more expeditiously than with the knife, or machine No. 5. The most perfect embossed fabrics are also made in this manner, by spreading the gum upon any figured fabric which may be used as a pattern. By this machine, as well as by the knife, the most perfect sheets of drapery are made by spreading the gum upon either a japanned or vulcanized India rubber cloth. In refer-

ence to both of these methods, as in the use of India rubber for cementing, it is necessary to observe the directions before given, page , and to see that the gum is used before it ferments or becomes sour.

MANIPULATION.

After the gum is rolled into sheets, or spread upon cloths, or blended with fibrous substances and made into the laminated fabrics, the manipulation of the manufacture is so very simple and easy, that much need not be said on the subject.

When the fabrics are taken from the spreading machine, they are in a state as adhesive as that of the native gum, and it requires great care and skill to handle the goods in working, to prevent the surfaces adhering together and becoming one solid mass, which cannot be separated. In order to prevent this, the sheets are rolled up in cloth, or dusted with flour. The articles which it is desired to manufacture being cut out, the seams are washed clean from the flour, and the parts being brought in contact, and pressed with the fingers or a small hand roller about the size of a dollar, they are firmly united, and the article is ready for vulcanizing. Some articles are cemented, or made up by machinery, as in the case of shirred goods and improved air work. Articles which are to be formed into various shapes, made of the compound, without cloth, require to be put on forms, or lasts, or into moulds, or to be otherwise supported, in order to prevent a change of shape when the gum becomes soft in the oven. The working of all the articles, whether of the gum or the fabrics, of whatever shape or form, admits of great cheapness and dispatch, as has been stated with some particulars, page .
Some peculiarities in the working of the different fabrics and wares are remarked upon in the description of them, under the head of Fabrics.

HEATING.

Heat is the great agent, when sulphur is present, in producing the *change* wrought in the gum, called vulcanizing. It is only by the use of these two agents, sulphur and heat, that any substance has yet been produced, possessing the properties described, as belonging to metallic or vulcanized gum-elastic.

The ovens or heaters that are made use of in the manufactories, are heated either by steam or hot air let into them upon the goods. The choice of method depends upon circumstances. Hot air ovens are commonly used by the shoe manufacturers, because a higher finish or lustre is thereby obtained on the goods. Some articles made of colored coated fabrics are discolored by the steam, to which the steam heat is not therefore applied; but for car and other springs, for masses of gum, for drapery, stayed compound, and numerous other articles and fabrics, the steam heat is preferred.

The time occupied in heating the goods or vulcanizing them, is commonly from four to six hours, during which time the heat, in the hot-air, or steam oven, in which the goods have previously been placed, is gradually raised to a heat varying from 250 to 300° of Fahrenheit, usually to about 265 or 270°. The different degrees of heat which are applied, depends upon the thickness of the gum, and the greater or less proportion of lead or other substances that are mixed with it. While the heat is being applied in the oven or heater, the gum becomes soft, approaching very nearly a melted state, at about the heat of 248°, after which the gum is hardened, as the heat is increased, until the change in it is complete.

The successful application of heat, so as to obtain a uniform result, in vulcanizing the goods without blistering them, was a labor attended with extreme difficulty. Dry ovens with heated air were first used; and for the purpose of obtaining the desired

finish or lustre, as well as for other reasons, it was found necessary to continue to use them for vulcanizing shoes, clothing, and other fabrics, after the steam-heaters were adopted, and preferred for many other articles. The difficulty of distributing dry heat evenly throughout an oven, is one that all who have had experience in baking of any kind are familiar with. The same thing may be said of the heating of dwellings. The difficulty is much increased at the high temperature necessary for vulcanizing.

This obstacle, however, proved to be trifling compared with the losses and discouragements that at first attended the manufacture in consequence of the fabrics being blistered in heating; but as the causes of this effect have been particularly stated at the close of the chapter, it is not necessary to repeat them in this place.

The expedients that are resorted to for heating different fabrics, and also for giving the articles their respective shapes, are very various; this is unavoidable, as all the articles, unless it be those that are made of the very thin fabrics, retain afterwards the shape that is given them when vulcanized. The gum softens in the oven, so that, when in sheets before it is vulcanized unsupported by being spread on cloths, it will not bear its own weight; for this reason also it becomes necessary to support many articles, such as shoes and garments, on lasts and forms.

These, however, were of no avail in the vulcanizing of hollow ware, such as balls, &c.; and this was not attempted until 1848, when the writer invented the process of heating them by the expansion of air contained in the articles placed in moulds. Further reference is made to this invention in a subsequent article on moulding. To attain all that appeared desirable to render the heating of every description of goods practicable, there was yet needed some means of heating gum-elastic veneers and small articles made of the hard compounds, such as buttons, covered buckles, &c., the former of which could not be treated like other sheets of gum; and the expense of a

mould for each separate article for the latter, besides the labor of handling them in the manufacture, would be too great to be practicable. The invention of vulcanizing the veneers between plates of metal under pressure, and that of vulcanizing the small and embossed articles made of hard compounds in finely pulverized soapstone and other fine earths, were made by the writer almost simultaneously with the want felt for the processes, in consequence of the invention of the things alluded to. These methods may be said to be indispensable to the manufacture of the foregoing articles with success. And a few of the first specimens of them were only produced in time for the London Exhibition of 1851, to which they were forwarded.

SOLARIZATION.

When caoutchouc prepared with sulphur is exposed to the action of the sun's rays for several hours, a change is produced in the surface of the caoutchouc, which may be called natural vulcanization. The solarizing of India rubber fabrics compounded with sulphur was practiced by the writer previous to the discovery of the artificial vulcanizing process. Upon the discovery of the process of vulcanizing by means of artificial heat, the solarizing process was abandoned; but recent improvements made by the author in the manufacture of caoutchouc fabrics, lead us to anticipate that solarization will again be used very extensively, particularly for the gutta percha variety of caoutchouc.

The effects of solarization extend to only a slight depth, and the process is not therefore applicable or useful with thick sheets or masses of caoutchouc; but in all the thin fabrics, or the fabrics upon which a thin sheet of caoutchouc is spread, solarization is an effectual and cheap process of curing India rubber.*

* The reader is here referred to page 73.

CURING OR TANNING,

Commonly known as the acid gas process. This has been employed since a patent was first obtained for it by the writer, by generating the gas with a mixture of nitric and muriatic acid, and immersing the article in it while the acid is in a heated state; but latterly the process has become much more efficacious and practicable for general use, by first dipping the goods in diluted nitric acid, and afterwards in chloride of lime and water: this method renders the effect uniform without danger of scorching the fabrics; beside, it is much less expensive than the former method.

CLEANSING THE GOODS.

PERFORATING.

The improvement made in gum-elastic fabrics by the simple process of perforating, will cause them to be extensively used for many articles for which they would not otherwise answer, on account of their confining perspiration and being uncomfortably warm. Two methods of perforating are practiced, one of which is accomplished by means of calenders set with needles, through

which the fabrics are passed while in a soft state. The other mode is that of perforating them, either before or after they are finished, with machinery, like that which is used for perforating fancy paper. By either of these methods the fabrics may be pierced in various patterns or devices, at a very trifling expense.

NAPPING.

There are two methods by which a nap is given to the various fabrics, one of which is to dust woolen or other flocks upon them, by machinery, such as is represented by No. 7. By this machinery a coat of dissolved gum is applied to the fabrics. The flocks of wool, or other material, are dusted upon them before they pass through the last set of callenders, which are covered with gum-elastic sponge, blankets, or other elastic material, which fastens the flocks without disturbing the coat of gum.

The other method applies only to the laminated fibrous fabrics of vellum, tissue, &c. Where the gum is applied upon one side only of these goods, the other side may be carded and dressed so as to form a nap of any length desired, or as long as the staple that is used will admit of.

EMBOSSING.

The method of embossing various articles, such as globes, dolls, toys, &c., differs materially from that of embossing India rubber fabrics.

The articles which are embossed are commonly those of the class of hollow ware, which are expanded by the force of heated air contained within them, when they are vulcanized, which

causes them to take the form of any design that is engraved in the mould in which they are placed. Articles which are solid, or nearly solid, with a hollow space within, may be shaped to any form, in the same way as is done in the manufacture of car-springs; or they may be made of gum-elastic sponge, to fill the mould of any shape, with or without any hollow being left in the article.

Globes, maps, or other articles, may be advantageously made in this way for the blind, and when the mould is inked or colored, they may be printed and embossed at the same time.

The fibrous, and other fabrics, are embossed in a very simple and cheap manner, by rolling them up in a figured cambric, or other figured goods of any desired pattern, as the India rubber fabrics are taken from the callenders while the gum on them is soft and warm. Being then left to lie for a few hours until the gum is cold, the India rubber fabrics become impressed, and exact copies are obtained of the surface of the goods with which they are thus brought in contact. The original copy is not injured even where silk or satin fabrics are used; and upon being removed, the impression or fac-simile of the copy remains; and after the India rubber fabric is vulcanized, it answers all the purposes for embossing gum-elastic fabrics, that an expensively engraved callender answers for embossing cambrics or leather.

Tissue, and other very delicate fabrics, are impressed in a similar manner, by spreading the gum upon the figured fabric, which is made into what is called an endless apron or belt. The layer of cotton which forms the tissue, is laid upon the apron or belt at the same time with the dissolved gum, by which means the fabric is formed and embossed at the same time.

JAPANNING, BRONZING, PRINTING WITH TYPE, COPPER-PLATE, BLOCKS, LITHOGRAPHY, &c.

The application of these arts to gum-elastic, is so exactly like the method in common use for paper and other articles, that instructions on these heads would be quite superfluous, except to say that for copper-plate, lithography, and type printing, the fabrics do not require wetting like paper.

GILDING.

These fabrics cannot be gilded in the same manner as leather, with a hot iron, because there is not sufficient adhesiveness in the fabrics to cause the leaf to hold. Therefore, in order to gild, varnish, or what printers term gold size, has to be used on the type or plate, and the leaf is afterwards applied as in the art of bronzing.

PLATING.

The term "plating" has been adopted for this improvement, from its resemblance to the art of plating metals, and also to distinguish it from the common method of coating India rubber cloths. The invention consists in interposing a bat or fleece of cotton wool, or other fibrous substance, between the coating of gum and the fabric. The gum is thus in part intermixed with the bat or fleece. Sometimes, however, the plating is prepared first in the form which has heretofore been described as tissue; in either case, the gum is by this process prevented from peeling off and abrasion—the importance of which improvement is further treated of under the head of "Plated Fabrics." It is by this process of plating that the manufacture of porous fabrics has been made practicable.

CORDING.

The goods described on page , are corded by the machine represented by No. 8. This may be done either while the goods are being manufactured or afterwards. When the cords are placed upon a single thickness, after it is manufactured, the cords should be cemented with liquid gum. When they are placed between two thicknesses of the goods, they do not require cementing. In all cases the operation of cording is a very simple one, adding but a very trifle to the expense of the goods.

THREAD CUTTING.

The cutting of thread from native gum-elastic has been practiced for many years in foreign countries. The process and machinery for doing it is very different from that used in the United States for vulcanized thread. It is now cut in the United States from the manufactured sheets of gum, of any length desired, as represented by No. 9. This machine was patented by Messrs. Tyre and Helm, of New Brunswick, New Jersey, being an improvement upon the callender cutting machine first used, represented by No. 10. The expense of manufacturing the vulcanized cord has become much less than that of the native gum cord, to say nothing of the difference in quality.

SHIRRING.

The shirred goods described on page , are corrugated by the machine represented by No. 11. A brief description of the

method of manufacturing these goods may not be uninteresting to those who are unacquainted with it, which is as follows: two pieces of woven cloth, ribbons, or any other suitable fabric, are first prepared by cementing them with liquid gum-elastic. Threads that have been cut from sheets of gum-elastic, drawn to the necessary tension, as represented by the cut, are run between the two fabrics previously prepared with cement; these fabrics having between them the extended threads, are passed between the compressing rollers of the shirring machine. The threads are made quite small by their tension, and the cemented fabrics are pressed around and between them, and adhere together. On being loosed from the machinery, the extended elastic threads contract forcibly, and by their contraction shir or corrugate the goods. In this way, that which it is apparently impossible to do without a great amount of labor, is accomplished almost without any, and with great rapidity, one machine turning off five hundred to one thousand yards per day.

MOULDING.

A very incorrect idea is commonly entertained relating to the manner in which gum-elastic is moulded. Attempts are frequently made by those who experiment with it to form articles, by filling moulds with dissolved gum, as they would do with pewter, plaster, or gutta percha. The solvents form so great a part of the bulk of dissolved gum, which is lost by evaporation, that moulds cannot be filled with it, as with the articles named. They might, however, be filled with undissolved gum, softened by heat, and under a heavy pressure, if such a process were necessary; but this would not form hollow articles, nor is it necessary even for solid articles, because the method of the inventor answers alike well for those that are solid, and those that are hollow, as herein described.

When solid articles are formed, the moulds are filled with the mass of compound, as near the size of the article as may be.

The expansion of the air and gases, which are unavoidably within the mass, will shape the article to conform to the mould.

When hollow ware of any kind is formed, sheets of elastic compound, artificial ivory, or fibrous fabrics, of the required thickness, are cut in two or more pieces, with a knife, punch, or dye, the edges of the pieces are either lapped, or butted and cemented together, barely strong enough, so that the article may be partially filled with air before it is put into the mould. By the expansion of the air and gases, while the article is vulcanizing, it is caused to fill the mould completely, even to the finest line engraved upon it, and having assumed, it retains, when vulcanized, the form and shape of the mould. The average thickness of the article being a little less than the sheet of gum used for it.

When an article is made from more than two pieces of the sheets of any considerable thickness, say one-eighth of an inch or more, it is not necessary that they should be inflated at all with air, as they will necessarily inclose enough to shape the article to the mould. It is not necessary that the pieces, when cemented together, should have any particular resemblance to the article which is to be moulded. The same pieces, which are cut in halves and inflated, or in four quarters, like the peel taken from an orange and not inflated, (the edges being butted together,) will make a bird, or a doll's head, as well as a bat ball. In other words, angular and divers shaped articles may be made from the same pieces as spherical and smooth ones. Tumblers, dishes, cups, &c., may be formed in this way, in united pairs from similar formed pieces; and when cut apart, after being vulcanized, two articles are obtained from one mould by each process of filling it.

Shoes or pitchers may be formed from the same or similar shaped pieces, space being left in the mould where the top or mouth of the article is formed, which leaves a comb or spur on the article; this being cut off, the article becomes opened and finished.

This method, which was first applied to the manufacture of

balls, is often alluded to in the second volume of this work, in the description of the articles, or the method of making them; for which reason a more particular description of the method has been given than of some of the other processes of the manufacture.

HOLLOW-WARE MOULDS.

Moulds of iron and brass were first used after the invention of this method of moulding gum-elastic. The difficulty of finishing such moulds, beside the expense of them, for articles that were manufactured extensively, became an important item. This drawback upon this valuable method, otherwise so simple and so practicable, has fortunately been removed by an invention of Henry B. Goodyear, brother of the writer, as follows: The pattern of the article to be made is first obtained, either in plaster, wood, iron, or any softer metal. A cast or form of the mould is taken from the pattern in plaster; from this plaster cast or form a brass mould is cast, finished and completed, with hinges and handles, like a bullet mould, with which the hollow-ware moulds are cast of Britannia metal as cheaply, so far as the expense of the manufacture is concerned, as the same number of bullets. This metal will bear the heat of the vulcanizing process, and is not expensive.

What adds much to the economy of the manufacture, in the use of this invention, is, that the same metal may be cast and re-cast for moulds for different articles, or for different sizes of the same article, with very trifling loss, as occasion may require. The method is so much less expensive than the forming and frequent changing of the different styles of shoe-lasts, that it is anticipated it may lead to the manufacture of some kinds of shoes, particularly small children's shoes, by moulds instead of lasts.

CONCLUDING REMARKS.

In conclusion of this chapter, the writer would say, that he has endeavored to be so explicit as to guard the experimenter against the mistakes that were the cause of serious hindrance and delay in his own progress, in experimenting for a great length of time. In doing this, although it may, in some cases, prove a detriment to his pecuniary interests, he would gladly remove from the way of all others the perplexities which he encountered, considering that it is warranted by the advantage that others may derive by this publication. Where persons are at such a distance that they cannot recognize the legal claims of the inventor, they are entitled to such information, as being conducive to the extension of the manufacture, and the welfare of mankind; and it is the wish of the writer that those who are disposed to recognize such claims, may be prevented from needless waste of time and money, which every one will not fail to encounter who undertakes to experiment with gum-elastic without any knowledge of the substance.

Further, it may be remarked that these instructions, brief as they are, may be of service to those who desire to make articles on a small scale, or for experiment merely, where access cannot be had to the factories, or is not desired from motives of secrecy, by those who invent new applications of the substance. It may be satisfactory to such persons to know, that they can now manufacture gum-elastic by hand with some advantage, however much more advantageously it may be done by machinery.

The present intention of the writer is to give, in a future edition of this work, a more minute description of the different processes of this manufacture, and the proportional ingredients of the different compounds which produce such various, although similar results.

It may be well, however, to state here for the benefit of those who may hereafter experiment or engage in this manufacture,

the practical difficulties that were met with in it, particularly those of blistering and fermentation, after the art of vulcanization was discovered. The fermentation of the compound and the impossibility at first of heating the fabrics evenly without their being blistered, presented the chief obstacles in the way of success. Owing to these, and the want of means to obtain suitable heating apparatus, it was more than a year before specimens could be produced sufficient to satisfy any one that there was any value in the invention. And after the manufacture was established by those who had ample means for experimenting with every facility, the discouragements in this art of heating were so many, and the actual losses by goods that were damaged were such, that for a period of three or four years more, or until 1845–6, it was considered by most persons to be exceedingly doubtful whether the invention could be made so practicable as to become generally useful; and these doubts of the success of the manufacture were not wholly removed until the gum came to be ground and worked with steam heat, instead of being dissolved with turpentine.

During the first year or two, the writer worked the gum always by dissolving it, and used chiefly the machinery with which the compounds are spread by the straight edge or knife, by which method the compounds are much more liable to fermentation on account of the greater quantity of turpentine that has to be used to make the gum liquid enough to be spread by this machinery.

This tendency of the compounds to ferment, particularly in those in which lead, litharge, vermilion, and chrome are used, occurs in hot weather, and also in cold weather when the compound is kept in a warm place; and if not spread within a day or two after it is mixed, it ferments or sours, and can not be vulcanized. As no one at first had any knowledge or suspicion of any such change in the composition, and as it did not always occur when the circumstances were apparently (though not really) the same, it was the occasion of much per-

plexity and uncertainty in perfecting the invention. After this cause of the failure of many experiments was detected and guarded against, when it became desirable to vulcanize specimens of any considerable thickness, or from $\frac{1}{32}$ to $\frac{1}{16}$ of an inch in thickness, they were found to be blistered in nearly every instance; and afterwards, when the manufacture of the goods was established, this defect rendered the goods so imperfect and unmerchantable, and occasioned so great losses, as almost to induce some of the manufacturers to abandon the business altogether. The causes of this effect also were not all known, and some of them were not even suspected for a long time. They were so numerous that it is no way surprising that it could not then be told to which of them might be attributed the failure of any particular experiment, or that it should then, in ignorance of them, be impossible to guard against them all at any one time. Another circumstance that served to mislead the inventor and subsequently the manufacturers, was the shortness of the time required to heat or vulcanize thin coats of gum, being only a few minutes, while it was not then known that it required the heat to be *gradually raised* several hours to vulcanize perfectly thicker coats of gum, or only $\frac{32}{100}$ parts of an inch and more, without blistering.

Blistering occurs when the gum is dissolved with turpentine under the following circumstances:

1st. When the turpentine is old or acidulated.

2d. When the sulphur is acid, as it is usually found in the market.

3d. When the white lead, gum or other ingredients, are accidentally or otherwise mixed with substances that generate gases of any kind in the fabrics while they are being heated.

4th. When any of the ingredients of the compound are wet when mixed, so that they generate steam in heating.

5th. When the turpentine is not well dried off before the fabrics are vulcanized.

6th. The fabrics are also liable to blister when solvents are not used, if a high degree of heat is applied too suddenly, or if

the heat is raised too rapidly, and also from the generation of gases.

The discontinuance mostly of the use of solvents in working the gum for some years past, together with the experience acquired in the manufacture, have overcome the difficulties that are alluded to, so that they no longer exist in an established manufactory, which renders the foregoing remarks less necessary than they otherwise would be; but as it is supposed that the use of turpentine or other solvents will again be resorted to to a great extent for the manufacture of some of the fabrics, it is deemed that the statement of these particulars will be found useful, especially to those who are unacquainted with the manufacture.

CHAPTER XI.

HEATED OR VULCANIZED FABRICS.

Metallic gum-clastic, the name first given by the author to his invention. Why so termed. Printed fabrics bound in volumes. An enumeration of the principal variety of fabrics. Easy combination of the gum with other substances. A table showing the uses of the metallic gum, as substitutes. Instructions for making up the fabrics after they are metallized or vulcanized. Elastic compound. Non-elastic compound. Stayed compound. Drapery. Medicated drapery. Caoutchouc cloths. Sponge. Tufted sponge. Sponge fabric. Fibrous fabrics. Tissue. Vellum. Plated fabrics. Felt, or vegetable leather. Corded fabrics. Barred goods. Knit goods. Shirred goods. Packing. Gritted goods. Napped goods. Embossed fabrics. Ventilated goods. Quilted fabrics. Perforated goods. Card cloths. Coated cloths. Porous fabrics. Indelible goods. Japanned goods. Hollow ware. Cord ware. Wire-work. Wicker-work. Air-work. Elastic cord. Braided cord. Elastic cordage. Covered cordage. Vellum cord. Sponge cord. Hard compounds. Caoutchouc enamel. Caoutchouc ivory. Caoutchouc buck-horn. Caoutchouc whalebone. Caoutchouc deal boards. Caoutchouc veneers. Enameled ware.

Soon after the discovery of the heating or vulcanizing process, the inventor applied the term metallic gum-elastic to the improved article. After the introduction into England, of the vulcanizing process, the material was there aptly styled vulcanized Indian rubber, although that title is not so truthful as metallic gum-elastic, the name given by the writer, at the time of its discovery in 1839; the word "metallic" being adopted in reference to the metallic ingredients, sulphur and lead, one or both of which are commonly used in this manufacture, sulphur with heat having been found, up to this time, indispensable to the process, and lead, or some other metal equivalent to it, being found useful in order to obtain economical or complete results in many cases. In order to give the reader an idea of the quality of these fabrics, some of them have been bound in this volume. Some few copies for public libraries have also been printed wholly upon these fabrics. To have given specimens of them all, would have made the work entirely too bulky, and would be more fitting a pattern card than a publication. In order to distinguish the numerous fabrics made from vulcanized gum-elastic, many of which are quite new, and in order to give the writer's opinion

of the uses to which they are best adapted, and by which they may be aided in the selection of any particular fabric for any special use, they are classed and described as follows:

ENUMERATION OF THE CHIEF HEATED OR VULCANIZED FABRICS.

		PAGE			PAGE
1. Elastic Compound,		182	22. Perforated Goods,		201
2. Non-elastic Compound,		182	23. Card Cloths,		202
3. Stayed Compound,		183	24. Coated Cloths,		202
4. Drapery,		184	25. Porous Fabrics,		203
5. Medicated Drapery,		185	26. Indelible Goods,		204
6. Caoutchouc Cloths,		186	27. Japanned Goods,		205
7. Sponges,	Tufted Sponge,	188	28. Hollow-ware,		205
	Sponge Fabric,	188	29. Cord-ware,		206
	Sponge Cord,	212	30. Wire-work,		206
8. Tissue,		190	31. Wicker-work,		207
9. Vellum,		191	32. Air-work,		201
10. Plated Fabrics,	or fibrous fabrics.	192	33. Elastic Cord,		209
11. Felt, or Vegetable Leather,		193	34. Braided Cord,		209
12. Corded Fabrics,		194	35. Elastic Cordage,		210
13. Barred Goods,		194	36. Covered Cordage,		211
14. Knit Goods,		195	37. Vellum Cord,		211
15. Shirred Goods,		195	38. Sponge Cord,		212
16. Packing,		196	39. Hard Compounds,	Caoutchouc Enamel,	214
17. Gritted Goods,		196		" Ivory,	215
18. Napped Goods,		197		" Buckhorn,	216
19. Embossed Fabrics,		198		" Whalebone,	216
20. Ventilated Fabrics,		199		" Deal boards,	217
21. Quilted Fabrics,		200	40. Enameled Ware,		218

Of most of these fabrics and wares, there are many varieties and styles of finish and ornamenting, which adapt them to such opposite purposes as almost to entitle them to be styled different fabrics. These fabrics form various combinations with each other, and the compound mixes readily with almost every other substance, such as earths and the oxides of metals, the numerous gums, bitumen, and oils, vegetable and all fibrous

substances; therefore it is no more surprising that a great variety of articles should be made from them than that a great number of words should be formed from the letters of the alphabet.

METALLIC OR VULCANIZED FABRICS AS SUBSTITUTES.

However absurd it may seem to propose these fabrics as substitutes for some things that are specified, it appears from the foregoing statements that have been made in regard to the adaptations of them, and from the descriptions which follow relating to their application, that they may be substituted for a variety of materials in common use, viz:

1st. For steel and iron, as illustrated by car springs.

2d. For lead, copper, and zinc, as illustrated by roofing, tube, kitchen-ware, &c.

3d. For slate and stone, as illustrated by gritted goods.

4th. For wood and wooden-ware, as illustrated by boxes, boats, casks, buckets, veneering, &c.

5th. For leather, as illustrated by shoes and boots, carriage cloths, hose, trunks, book-binding, belting, &c.

6th. For twine, tape, cord, and cordage, as illustrated by various articles of this sort.

7th. For cloth of cotton, wool, flax, silk, hair, &c., as illustrated by clothing, carpeting, umbrellas, sails, bags, furniture covering, &c.

8th. For oil silk and oil cloth, as illustrated by articles for medical uses, surgery, and floor cloth.

9th. For paper, parchment, &c., as illustrated by maps, charts, globes, drum-heads, covering for books, boxes, walls, &c.

10th. For crockery, pottery, and glass-ware, as illustrated by pitchers, ewers, tunnels, and basins.

11th. For wicker and basket-work, as illustrated by baskets, covering of phials, bottles, demijohns, &c.

12th. For sponge, and curled hair, by cushions, matresses, pillows, &c.

13th. For bristles, and broom-corn, by brushes, scrubs, &c.

INSTRUCTIONS FOR MAKING UP THE FABRICS AFTER THEY ARE VULCANIZED.

If any elastic cement could be found that would unite these fabrics firmly, so that they could be made up as expeditiously as they are made at the factories before they are vulcanized, and also equally impervious to air or water, it would be an invaluable acquisition. This can with no more reason be expected, than that a thing can be adhesive and inadhesive at the same time.

The great object so long sought after, that of divesting gum-elastic of its adhesive quality, has been so completely effected in these fabrics that they cannot be made again adhesive even when it is desired.

The following directions in relation to making up various articles described in this work, from the different fabrics which are to be found in the market, may be found useful.

When a button-hole is cut, either in the drapery or metallic compound, care should be taken to cut it at the lower end, with a round punch, to correspond with the size of the shank of the button or knob with which it is to be used. A simple, straight-cut button-hole will tear out more easily.

Whenever the fabrics called elastic compound, or drapery, are stitched to other fabrics, a stay of leather, vellum, or some other firm goods must first be cemented to it, or the stitch will not hold.

Fish or other glue, is the strongest cement that can be used for these goods, when they are not to be exposed to much wet. Dry heat will not injure this cement. Any of the coated cloths, and also all the laminated fabrics, may be stitched with

the needle and made into garments, or other articles, to fit and suit the purchaser, and they can be made effectually water-proof, after they are stitched, by the use of any of the water-proof varnishes, or by a cement of India rubber dissolved in pure camphene or turpentine, and applied to the seams. This is more effectually accomplished when a welt of the same material is used in the seams.

These goods may also be mended with patches of the material, by the same means, and small leaks may be effectually stopped in air-work or water-proof articles by a few drops of collodium, or gun cotton varnish; but this varnish does not adhere sufficiently to hold a seam where there is much strain; besides, it dries too suddenly to be used in such a way. Shoemakers' wax, or a drop of hot sealing-wax, will often answer for stopping a small leak in air-work. Directions are given in the second volume, on this subject, for some articles, with the descriptions of those articles as they are made up at the manufacturers'.

Since the foregoing article was first stereotyped, a gum-elastic cement has been discovered by the writer, which appears to answer all the ends that are desired, for cementing the vulcanized fabrics, except that of holding a strong seam where there is much strain. But it answers well the purposes of mending garments, patching air-work, umbrellas, and for cementing gum-elastic soles to leather shoes, as well as for the purpose of making up many articles from the lighter fabrics, such as tissue and vellum. The public will, ere long, be put in possession of the means of doing many things themselves with these fabrics, which could otherwise only be done at the factories

ELASTIC COMPOUND.

The term *elastic compound*, is applicable to the heated or vulcanized gum in heavy sheets and masses, or blocks, which are put in the market uncombined with cloth or other fibrous substances, for the purpose of being cut up and applied to various uses, where elasticity is required, either by tension or compression. Its properties have been described under the head of metallic gum-elastic.

It is made by the licensees in sheets, threads, and masses, of any form or thickness for the uses for which it is required.

NON-ELASTIC COMPOUND.

The materials of which this substance is compounded are in some cases the same as those of the elastic compound. It is made non-elastic, and at the same time flexible, by varying the degree of heat in vulcanizing and the proportions of the ingredients. Finely pulverized soap-stone or talc is added to the mixture, when the compound is intended to be used for articles that are much exposed to abrasion.

STAYED COMPOUND.

This is a description of vulcanized gum-elastic fabric, of various thicknesses, combined with inelastic stays. When the alternate coats of gum are spread to form the sheet of stayed compound, stays, or strips of coated cloth, silk knit goods, or vellum, of suitable widths, are cemented either in the middle or upon the outside of the sheet, at such distances apart, that when the sheet is cut up between the stays, it will form springs of the size and length desired, which may be attached by means of button-holes, or stitched in the stays, to other articles; for it is a defect of gum-elastic, when uncombined with other substance, that it will not hold stitches. This defect is obviated by these stays, and the goods are thereby adapted to a great variety of uses, such as suspender ends, shoe springs, corset springs, shoulder braces, &c. Another description of stays is found to be well adapted to other purposes, as follows. The stays are made of small hose, of India rubber canvas, cloth, or knit goods, which are cemented between the sheets of compound, as before stated, at suitable distances for the articles or which the goods are designed. When the springs are cut apart, a cord may be passed through the hose, whereby they may be attached to other articles. For gate, door, or cupboard springs, and other like uses, the hose is to be slipped over a pin or staple attached to the door, gate, &c. When these springs are to be attached to webbing for girths, circingles, stirrup leathers, &c., the hose is to be cut open at the end of the spring, and the web or leather stitched in between the two parts.

DRAPERY.

Drapery is of the most delicate texture, and having been subjected to a finishing process, which gives a peculiar dryness and softness of the surface, it differs in these respects from many of the other fabrics. This leaf is a specimen of the finer sort, though others are made very much lighter, weighing only one-quarter part as much as this. Such, however, are made rather as specimens or curiosities of the art, than for use, except it be for medical purposes. When the demand becomes greater for this material, it will be among the cheapest of gum-elastic fabrics, and can be afforded at an extremely low price.

The extreme tenuity of this vegetable substance, may be compared to gold leaf among the metals.

Many uses of this novel article are yet to be ascertained. The following may be specified. Pocket maps, bandages for the stoppage of hemorrhage, and for fomentations. It is also useful for the covering of the mouths of bottles and jars, and for the common uses of oil silk, beside those hereafter described among the applications of gum-elastic. The most finished and perfect drapery is made of the gum dissolved in camphene.

MEDICATED DRAPERY.

Medicated drapery differs from that already described, only by having mixed with it any ingredient desired, whether opium, camphor, or perfumery; but to what good purpose must be left, as in the case of all medications, for the physician and patient to decide. Numerous cures of rheumatic complaints are said to have been performed by this article, some of which have come to the knowledge of the writer. His opinion in reference to the drapery, whether medicated or not, is this; that in sudden and slight attacks of rheumatism, stiff necks from cold, &c., it is a useful remedy, but in cases of chronic rheumatism, and gout, it is of no value. On this head, the inventor speaks from personal experience. As a remedy in the case of slight though very painful burns and scalds, it may be highly recommended.

CAOUTCHOUC CLOTHS.

These are made of thread spun from the elastic compound, and woven into cloth. Only a few yards of this fabric, as specimens, have yet been made. The first yard was woven in a hand loom in 1841. Machinery is yet to be constructed to spin and weave it to advantage. To speak of its utility would be premature, until facts that are obvious to the mind of the inventor shall be demonstrated to the satisfaction of others. It is porous like other woven cloths; it therefore would not, like other India rubber fabrics, be objectionable for wearing apparel, on account of confining the perspiration of the body. Although it would not, like them, be water-proof, yet it would shed rain much better than fibrous cloths of cotton or wool. Its great recommendation would be durability, economy and cleanliness. The opinion is entertained that fabrics of this sort will ultimately be made to advantage, in imitation of camblets and the coarser kinds of silk, similar to the specimens which have already been produced. The same general remarks may apply to this fabric that have been made relating to porous fabrics, although they would differ from them in two particulars—the caoutchouc cloths would be more cloth-like in appearance, but more expensive than the porous fabrics.

SPONGE.

During the process of vulcanizing, the blistering of the gum presented originally an obstacle to the art which at different times it seemed impossible to overcome. It was the occasion of great loss and hinderance, both to the inventor and the licensees who first engaged in the manufacture. This circumstance led to the production of the substance now called gum-elastic sponge. After the cause of the blistering was found to be owing to gases generated in the gum under certain circumstances, it became necessary only to compound the gum with such substances as would generate the gases freely, so as to make the whole mass a sponge. Subsequently the effect of the gases was to produce great irregularity in the shape of the gum that was sponged, so that no particular form could be given to it; but on resorting to the expedient of heating in moulds, as in the case of hollow-ware, it is now made to assume any form which is desired, and any degree of porousness, whether of fine or coarse texture, which has given rise to many useful applications of the article, among the most important of which may be specified horse-collars, saddle and harness pads, corks, clothes brushes, cushions, toys, &c. In order to form these articles with a smooth surface they are coated with a sheet of elastic compound previous to being vulcanized. This substance will be found exceedingly durable for any purpose to which it may be applied.

TUFTED SPONGE.

This is formed by vulcanizing a sheet of the sponge mass between two air-tight fabrics, which forms a coat upon each of the fabrics, resembling a heavy shag, fur, or plush, which is used as a veneer or coating upon the bathing gloves and mittens, described page .

SPONGE FABRIC.

Gum-elastic sponge may be formed into a sheet of any desirable thickness, unconnected with any other fabric, or it may be laid upon or between other fabrics, either in the process of manufacture or afterwards.

The uses of the gum-elastic sponge fabric will undoubtedly be very numerous; but the article is so very novel that it is yet too soon to attempt a very particular account of them.

FIBROUS FABRICS:

HEREAFTER DESCRIBED AS TISSUE, VELLUM, PLATED FABRICS, FELT, AND CORDED FABRICS.

After the change was wrought in caoutchouc by the process of vulcanization, comparatively few mechanical obstacles remained in the way of its successful application to any articles required to be made of the gum alone, or when uncombined with any fabric or tissue; but in all combinations where a

fabric or tissue was coated with the vulcanized compounds, the same obstacles of chafing and peeling from the fabrics continued to exist as before.

The great liability of the gum to peel from all woven cloths, has been well known to all manufacturers, since the first manufacture of India rubber. This difficulty was not removed by the discovery of the vulcanizing process, and the sanguine hopes that were entertained, that gum-elastic could be made a substitute for animal leather, to any considerable extent, were for a time nearly abandoned. For many years the inventor sought to surmount the difficulty, by applying the gum to every description of fabric that could be found, that would be likely to answer, and to others which he had made expressly for the purpose, at great expense, without attaining the object. The difficulty remained until it was obviated by the manufacture of the fibrous fabrics. In these goods the fibre is so completely incorporated with the gum that it is impossible to peel it.

The primary importance of the vulcanizing process has been repeatedly alluded to; but it has become generally available and extensively applicable, chiefly in consequence of the invention of the fibrous fabrics here described. The invention of these fabrics is only secondary to that of vulcanization, and is as important in the mechanical combination of the materials as vulcanization is in their chemical combination.

These fabrics, and their uses, are so various, answering the widely contrasted uses to which paper, cloth, and leather are applied, that a description of them under the general head of fibrous fabrics, would not be sufficiently explicit. They are therefore described according to their thickness, as tissue, vellum, plated fabrics, felt, and corded fabrics. Perhaps the most valuable application of gum-elastic, is its substitution for leather. It could not be so substituted, to any considerable extent, previous to the invention of the fibrous fabrics.

TISSUE.

Tissue is formed of a layer of cotton wool, which is sized before it is coated with gum. The dissolved gum is combined with it by the spreading machine, which makes a complete admixture of the two articles. The fibre of the cotton is not broken, as in the manufacture of paper, and it is, therefore, very much stronger, and when corded, stronger than woven fabrics of the same weight.

Knowing the very low cost at which this fabric will be ultimately manufactured, the inventor does not hesitate to advance the opinion, that in the course of a few years it will be used instead of the more costly kinds of paper; and occasionally, if not ordinarily, for the issuing of mammoth sheets, placards, handbills, &c.; after having been used for such a purpose, the printing may be removed by boiling in a strong solution of potash or common lye. The owner of such an article would have goods suitable for a lady's apron, a cape, the covering for an umbrella, or some other useful article. It might be re-ornamented, or it might serve again its original use. Tissue has, therefore, an intrinsic value, which paper has not. Its adaptation to the printing of pocket maps, school atlases and globes, is already beginning to be well understood; and for the papering of walls, particularly in damp situations, its advantages are too obvious to need comment. The same remark may be made of it for the covering of paper bandboxes. It is like drapery, useful as a substitute for oil silk. To suggest the idea that it may be made useful for ladies' capes, bonnets, hoods, and also for ribbons, may appear absurd to some who do not yet understand the high state of perfection to which the manufacture is destined to be brought; and yet it is evident that some of these articles must be desirable in stormy weather. Tissue is perhaps the most useful of all the fabrics, in a warm climate, as a protection from rains; and also when napped, it is equally well adapted for that use in cold climates.

VELLUM.

This is made of a bat of cotton, of about one-quarter to one-half an inch in thickness, like that commonly made and used for cloak wadding. The gum is pressed into, and intermixed with the wadding, at one operation of the spreading callenders; and like the other fibrous fabrics, it is manufactured with great rapidity.

It is made impervious to air and water with much less gum than the woven fabrics; besides, the gum is not liable to peel off as it does from other fabrics. It is, for most purposes, the cheapest, as well as the best of the non-elastic fabrics; and when corded, as described in the chapter on corded goods, page —, bids fair to supersede the coated cloths entirely for many purposes, particularly for light articles of wearing apparel, and also, when corded, for the heavier uses of India rubber canvas. It is made, when desired, in imitation of various kinds of morocco, kid, and buff leather, and of different thicknesses and degrees of strength, according to the thickness of the wadding. When embossed in imitation of hair cloth, or otherwise ornamented and perforated, it may be used for the covering of chair and sofa seats.

The most important uses of it will probably be those of book-binding and air-work, a particular description of which may be found under those heads.

It may be safely recommended for most, if not all, the purposes for which common sheep skins and skivers are used, and for many uses it is more durable than the best calf or Russia leather. For wearing apparel, various thicknesses of this fabric, with different kinds of nap, are suitable, according to the climate or the occupation and wants of the wearer; it is exactly suitable, on account of its softness and durability, to be used for the covering of counting-house, portable and school desks, and writing tables.

PLATED FABRICS.

The term "plated" has been adopted to designate a peculiar method of coating cloths with caoutchouc and its compounds. Plated fabrics are made by the interposition of a thin bat or fleece of cotton or flax fibres between the gum and any fabric to which it is applied, whether woven, knit, or felted. The gum, when applied in this manner, is partly intermixed with the bat or fleece of fibre, and both are securely united to the fabric, and are held firmly even upon linen or any canvas made of hard-spun thread. The coarser and more open the fabric, the greater is the economy, and the advantage every way in plating, instead of coating it by the old method of applying the gum to the cloth, because the plating is laid *over* instead of being forced *into* the meshes of the canvas; the consequence is, that the coarsest and most open canvas is, when plated, rendered water-proof with about the same quantity of gum as is required for the finest muslin. Heretofore, when gum-elastic was applied to woven fabrics, and especially to linen or coarse fabrics, *without the interposition of fibres*, the gum was not only easily peeled or chafed from the fabric, but it required so great quantity of it to fill the meshes of the fabrics, and render them water-proof, that their expensiveness, together with their great weight, almost wholly prevented the manufacture of this class of caoutchouc fabrics. The same obstacles of weight and expensiveness have always existed to prevent the manufacture of heavy oil or other water-proof cloths sufficiently strong and yet cheap and light enough for the uses for which such fabrics are desirable.

By this improved method of plating fabrics, they are made so cheap and light, and yet so durable, that there is good reason for believing that this method will be generally adopted, but more especially for linen goods, heavy canvas, and bagging.

FELT, OR VEGETABLE LEATHER.

This fabric is very similar to the other fibrous fabrics. It however differs from them inasmuch as it is made of a greater variety of fibrous materials which are put together in a different way; it is also applied to some uses to which the other fibrous fabrics are not applied, such as sole leather, different kinds of packing, foundation of carpeting, &c. The fibrous materials of which it is made, such as cotton, cotton waste, flax, hemp, hair, wool, rags, waste leather, &c., separately or combined with one another, are first picked and then thrown together in bats or sheets of a suitable thickness, instead of being carded in alternate layers, as in the other fibrous fabrics; consequently the fibres of the bat or sheet are more entangled and not so likely to split. When this fabric is used as a substitute for sole leather, to be used on shoes and for some other purposes, one-fourth to one-half its thickness is made of caoutchouc whalebone, in order to give greater firmness and hardness.

CORDED FABRICS.

Tissue and vellum are made very strong, (and are difficult to be torn,) when corded with silk, thread, twine, or spun-yarn, for the same reason that muslins and other woven fabrics are strengthened by being barred or corded with threads stronger than those of which the cloth is made.

The different fibrous fabrics, when corded in this manner, are even stronger than India rubber fabrics that are made of woven cloths. The uses of these fabrics are the same as those of tissue, vellum, and vegetable leather; but on account of their great strength, they are more extensively applicable to many purposes for which those fabrics would not answer, such as ships' sails, tarpaulins, coach cloths, &c.

The great recommendation of these goods is, that they possess the greatest strength with the least possible weight, at the same time that the gum does not peel or chafe from them as it does from coated cloths.

BARRED GOODS.

These consist of various articles made of the vulcanized fabrics, which are strengthened by narrow bands or strips of coated canvas, which are cemented upon the outside of the articles or fabrics in a sort of net-work. By these means a lighter fabric can be made use of for any given purpose than otherwise could be, and the greatest strength is thereby obtained with the least weight. The wear of the articles made in this way comes very much upon the bands, which makes them better adapted for ships' sails, tents, mail-bags, awnings, &c., than the plain fabrics.*

* Of this fabric, manufactured from a light and inferior article of cotton duck, a topsail of the packet ship "Stephen Whitney" was made; for a report upon the qualities and performance of which, the reader is referred to the letters of Capt. Popham, page   of this work.

KNIT GOODS

Are made of knit fabrics covered on one or both sides with gum-elastic. Until recently, India rubber, as well as the vulcanized gum-elastic, has been put invariably upon woven cloths, but it is supposed the use of the woven cloths will be in a measure discontinued, and the unwoven fibre substituted in their stead for the manufacture of caoutchouc fabrics.

There are, however, certain uses of the knit goods, for which, on account of its elasticity, together with its strength, it will probably always have a decided preference over both the woven and the fibrous fabrics. Among these uses may be specified boots, shoes, gloves, mittens, some kinds of springs, and carriage cloths. For further particulars, reference is made to the specification of Patent granted for these goods in the United States.

SHIRRED GOODS.

When these fabrics were first made known, their novelty attracted much attention, being justly considered very curious. The inventor was indebted to this circumstance, as has been previously stated on page , for his success in drawing the attention, first of his friends, and afterwards of the public, to the more important discovery of vulcanized gum-elastic.

The goods were first made of ribbons, and used for suspenders, not long after of silks and muslins. Shirred or corrugated goods have been used for springs of various kinds, besides suspenders, particularly shoe and corset springs.

The license for manufacturing this fabric was sold to Mr. H. H. Day, in 184 , since which time the manufacture of these goods has been exclusively in his hands. A brief description of the method of manufacturing them may be found in Chapter

PACKING.

Packing is made of cotton, wool, or other fibrous substances, ground up with elastic compound. In consequence of the invention of this fabric, great economy is introduced into the manufacture of gum-elastic, as the scraps and sweepings of the factories, that were formerly thrown away, are now made into the best goods of this kind. This fabric is used for engine-packing, and deck-scrubs for ships. It is also generally used for the soles of gum over-shoes, for which it is preferred, being lighter, not so likely to slip, and more durable than soles made of gum-elastic only.

GRITTED GOODS.

India rubber fabrics are gritted with different substances for different purposes, with sand, as patented,* for car covering, &c., to prevent their being slippery, and also to prevent their igniting by sparks from the engine, and with emery, pumice, and other substances for buffing, sharpening edge tools, erasing pencil marks, &c. Recently some specimens have been made of gritted goods, which, it is supposed, will be used as a substitute for slates, memorandum paper, &c.

The grit, of the kind required, is first ground and incorporated with the gum, after which the fabrics are coated with it in the usual way.

* By Nelson Goodyear, brother of the writer.

NAPPED GOODS.

Specimens of India rubber cloths napped with woolen flocks, were manufactured by different persons as early as 1835, and before they were made by the writer. These goods decomposed like other India rubber goods of that time, only sooner than others, on account of their decomposition being accelerated by the oil in the wool. Napping has recently proved successful upon the heated vulcanized fabrics, and for many uses they are superior. For wearing apparel, they are more comfortable and pleasant, and for blankets and imitation buffalo robes, they are warmer than India rubber goods that are not napped. The different fabrics are also, by being napped, made exactly suitable for the covering and protection of furniture, in such articles as table spreads, pianoforte covers, &c. The different methods of napping are noticed under the head of Manufacture, Chap. X.

EMBOSSED FABRICS.

The fabrics which are embossed with the greatest advantage, are gum-elastic veneers, plated goods, and vellum.

This leaf is a specimen of the thinner sort of embossed vellum, such as is designed for pocket books, paper boxes, &c. The heavier kinds are made in imitation of morocco and leather, for book-binding, trunks, and other uses to which leather is applied.

The art of embossing with cambrics, and other fabrics, was first adopted by the inventor in 1835, before the discovery of either the acid gas or the vulcanizing process. The method of embossing, which is described page , is of importance on account of its simplicity and cheapness, for although gum-elastic goods may be embossed with callenders, like leather or other fabrics, the figures cannot be made to endure the heat of the vulcanizing process so well in that way; and the cost of the patterns, if embossed with callenders, is enormously increased by an expensively engraved callender, which is required for each pattern.

By the method of embossing with other stuffs, the figure is first transferred in the manner described, into a piece of India rubber fabric; which, after it is vulcanized, answers all the purposes of a costly engraved metal callender, for embossing other India rubber fabrics. The original not being injured by the copying of it into gum-elastic, gives to this process the advantage of an unlimited variety of styles and patterns, at a very trifling expense.

VENTILATED GOODS.

The unique appearance of these goods may make them objectionable at first, as wearing apparel, and yet they are not more novel in that respect than many articles that become fashionable. When applied to horse blankets, tents, &c., there can be no objection of this sort. These goods are made of barred or corded vellum. The articles are perforated immediately underneath the bars or cords in different parts, according to the construction or use of the article; a leaf or fly is cemented upon the bar or cord over the openings. The leaf or fly is a little raised by the bar or cord above the openings, so that perspiration can escape, while rain or wet is prevented from entering. The leaf or fly should in general be a little fulled on the upper edge, and tacked or cemented on the lower edge. For further description see diagrams, Vol. II., page . Another kind of ventilated goods, such as pillows, cushions, life-preservers, &c., are ventilated by being perforated, as represented in the drawings of those articles, Vol. I., page .

QUILTED FABRICS

Are made of the laminated fibrous fabrics, in a manner very similar to the method of manufacturing air-work, already described. The goods are quilted in any desired pattern, by cutting the patterns either by hand or machine punches, from bats of cotton or wool; these are next placed upon the surface of the fabric, at the distance of from one eighth to one fourth of an inch apart; another sheet of the fabric of the same size as the first, is then laid over the whole, and pressed down either by hand or by machinery, the callenders or rolls of which are covered with an elastic substance. The effect is that the two pieces of the fabric adhere together in the spaces between the patterns cut out of the wadding.

If tubes are inserted into articles of this kind, they form the safest and best kind of air-work, with the exception that the goods made in this way are not quite so light and portable as those which are inflated with air only. These goods have, however, one recommendation, which is of more importance than portability or lightness; they are safe, and may be depended on as life-preservers.

A newly invented description of garments are made in this manner, which are convenient to be worn, and yet may be considered infallible life-preservers, whether they are inflated by the tubes or not. Air is necessarily inclosed in the cells of these garments with the wadding, in the manufacture. A cape, coat, or poncho, which is divided into a thousand cells or compartments, might be damaged or perforated in five hundred different places, and it would yet infallibly prevent the wearer from sinking in the water. For further description see Vol. II., page .

PERFORATED GOODS.

These are made either from the laminated fibrous fabrics, or drapery. A peculiarity of all these fabrics is, that they may be pierced without any material injury as to strength, and the fibrous fabrics will not fray or ravel as the coated cloths would do, if pierced in the same way. Some of the uses which are contemplated for these goods, are shoe-springs, bandages, sieves, cullenders, strainers, bolting cloths, &c. It may also be substituted, in a great many cases, if not very generally, for woven wire cloth. Besides these uses, there are others which it is thought will become yet more important in their application to shoes, gloves, and wearing apparel. Perforating the goods will, of course, chiefly destroy their water-proof quality. Durability, cleanliness and economy would, however, be the object contemplated in the use of these fabrics.

CARD CLOTHS.

This article, or at least its application as a substitute for leather for machine cards, is originally an English invention. It was first made of the native gum by cementing a number of woven cloths together. Beside being used for the above purpose, it has been found useful, when vulcanized, for some descriptions of light belting, and particularly for the rail way belts of cotton carding machines.

COATED CLOTHS.

Cloths of every description may be coated with compound when it is desirable to make them water-proof or very durable, with greater or less advantage.

The writer considers them generally less useful than the laminated fibrous fabrics called tissue, vellum, and plated fabrics, although some of them, particularly very light silks, have the advantage of greater strength in proportion to their weight, and they can also be wrought into different articles by stitching, better than the fibrous fabrics, which is often a convenience to the purchaser.

The uses of these cloths are already so well known, and their application is so often referred to in the following pages, that a further description here is considered unnecessary.

POROUS FABRICS.

Probably no new property has ever been given to caoutchouc fabrics, which will serve so much to extend the use of them, as that of porousness. That which has been chiefly aimed at heretofore, has been to make their water- and air-proof qualities to the greatest extent available. The idea was never, until recently, entertained of making the goods porous, so that they might be used instead of leather for shoes for constant wear, and also for clothing and other purposes.

But now that such a fabric is produced, that is pervious to air and impervious to water, when not under pressure, (two properties which are not found united in any other fabric,) it is not easy to foretell how far the use of gum-elastic may be extended by the introduction of this improvement.

Any one who will consider the subject attentively, may perceive that there is very much needed, especially for the poorer classes, some cheap and durable fabric, which will not be easily soiled, and which will not, like cotton and woolen fabrics, accumulate filth when brought in contact with it; making it necessary to submit them to the cleansing process of scouring and washing, which is commonly attended with much expense of time and money. The writer anticipates a material or fabric in the porous cloths, which will in a great measure, if not wholly, meet the want which is so obvious, and which will give to the humble and laborious classes of mankind all the advantages of cleanliness and decent apparel, that are now enjoyed by those having ample means.

The materials of the fibrous, the plated, and the porous fabrics are the same, and the method of manufacturing them is the same, except that the gum is applied in the case of porous fabrics in a more liquid state than is done when the same fabrics are made impervious. They are made more or less porous, at the option of the manufacturer, by the gum being

made more or less liquid. Porous fabrics may also be made by mixing with the compounds substances that are soluble in water, which can be dissolved out.

INDELIBLE GOODS.

These are of three kinds. The first consists of fibrous fabrics, silks, and other fancy stuffs, which are printed and afterwards coated over with a thin coat of gum-elastic cement.

The second kind consists of maps, globes, charts, carpeting, table and piano covers, &c., which are printed or painted by different methods, upon the various India rubber fabrics, and being coated over in the manner before alluded to, the printing and painting become indelible in every sense of the word; so much so, that they cannot be altered or removed by any art of chemistry, without destroying the fabric.

The third kind consists of carpeting, &c., in which the patterns, or figures, or colors, are applied with a brush, or by stenciling, the coloring material being a thick cement of dissolved caoutchouc.

This is an art which has not yet been practiced to any considerable extent, but enough has been done with it to give assurance that it will prove of great utility, when carried on extensively.

JAPANNED GOODS.

The high lustre which has recently been given to the surface of vulcanized fabrics, renders the use of these fabrics of less importance for japanners, than was at first anticipated, and also obviates the necessity of their being finished by japanning. Cord ware and wicker-work may yet be japanned to advantage, for although the vulcanized fabrics are made with a high finish, equal in appearance to the oil japan, yet the finish has not the brittle hardness or lustre of the oil, and is more easily scratched than the oil japan.

HOLLOW WARE.

These goods are made of elastic compound, and consist of balls, toys, breast-pumps, bottles, and a variety of other articles, described hereafter among the applications.

The goods are vulcanized in moulds, and by the expansion of the air within the articles while heating, they are caused to fill the moulds, which may be made of any shape, and of a figured surface if required.

The moulds are commonly made either of block-tin or cast-iron. The number and variety of this class of articles has been greatly increased by the moulding and heating of gum-elastic sponge, which is found to answer for many uses better than articles which are quite hollow. From present appearances we may venture the opinion, that the articles of gum-elastic hollow ware will become as numerous as those made of iron.

CORD WARE.

This ware is made of vellum cord, which is commonly wound closely upon a pattern or form of the article designed to be made. When the shape of the article is irregular, or larger at the bottom than at the top, the form is made in pieces like a hatter's block, so that they can be easily removed. Before being wound, the patterns or forms are covered with gum-elastic vellum or plated fabrics, so as to form a smooth surface for the inside of the articles, as well as to strengthen them by holding the cord together; for these purposes, the cord is sometimes flattened or made half round or square.

A great variety of articles are made in this way, such as buckets, bowls, ewers, trunks, valises, hat-boxes, &c. Articles are more expeditiously made in this way, and they are much more durable when so made, than the same articles are when made of coated canvas; vellum cord being better calculated to resist the kind of damage to which such articles are commonly exposed.

WIRE-WORK.

These goods are made by covering metal wires with a number of thicknesses of vellum; these may be twisted or laid and cemented together so as to form a strong rope or strap; the strength of metal wire is made available in this way, the wire being kept by the elasticity of the gum from being bent so short as to break. The single cords, when netted or braided like wicker-work, or wound like cord ware, make a description of articles of the most substantial kind, such as the water-hose and mail-bags, described among the applications, Vol. II., which, in addition to the common advantages claimed for other articles

of the kind, have one peculiar to themselves, that they cannot be cut with a knife. Under the above head may very properly be included some articles such as trunks, boxes, &c., which are strengthened by having combined with them straps, or pieces of iron, which are first covered with gum-elastic vellum, or tissue. Some of these articles will be found described in Vol. II.

WICKER-WORK.

Wicker-work is made in the same manner as the cord ware already described, except that the vellum cord is braided or woven chiefly by hand, in open-work, into baskets and such other articles as are commonly made of willow. When lined with gum-elastic vellum, the same are substituted for baskets lined with tin or zinc.

The advantages proposed by this description of ware, are durability and cleanliness. The more bulky articles of this sort may be made by covering rattan, reeds, or willow, with vellum. Among other things, a very light and durable row-boat may be made of lined wicker-work.

AIR-WORK.

This is a term which has been technically applied to all articles that are inflated with air, such as beds, pillows, cushions, life-preservers, &c. Some observations upon this kind of work, and descriptions of many articles such as have formerly been made, may be found in Vol. II., page ——. But the work which is particularly referred to here, and is thought to be entitled to a description as a separate class of goods, is of a very different kind, and but recently invented.

The simplicity, cheapness and completeness of these goods

is attained, in consequence of the previous invention of the fibrous fabrics, and the gum-elastic tube, described in Vol II., page ——. The method of manufacturing these goods is as follows: The patterns which form the cells, or air chambers of these goods, are cut from napped gum-elastic tissue, of any form to suit the fancy, but more commonly in rings, squares, or diamond patterns. These are laid between two pieces of gum-elastic tissue, vellum, or vegetable leather, in pairs, with the napped sides of the patterns placed together; the effect is, that when the two fabrics between which they are placed are pressed together, one of the patterns will adhere to the upper, the other to the lower piece of fabric. The two patterns are prevented from adhering together, by the nap on the surface; conductors of the same material are placed between the cells, to connect them all together, to be inflated by one tube; or in separate rows, to be inflated by a number of tubes, or one tube for each row of cells; thereby rendering the article more safe. When the two pieces of fabric are pressed together, they adhere only between the cells, by which means the article is formed into as many compartments as there are patterns. Two pieces of the fabrics, of from thirty to fifty yards, is first covered with the patterns, so placed as to form the bed, life-preserver, or other article designed to be made; another piece of the same width and length is placed upon them, the two are pressed together by hand rollers, or what is much more expeditious, being passed between callenders, covered with an elastic substance, the articles are formed and ready to be cut apart, when, after the tubes are inserted, and they are vulcanized, the articles are finished.

Those who are acquainted with the manner in which air-work has to be constructed, when it is made of coated cloths, will at once perceive that great complexity of workmanship is obviated, as well as material saved, by the method above described; and as these goods may, like shirred goods, be made by machinery, with great rapidity, it may reasonably be expected that a complete change will hereby be effected, both in the first cost and quality of air work.

ELASTIC CORD.

The art of cutting the native gum into threads, was first practiced in Europe, where machinery was invented for the purpose. The native gum bottles were pressed out to a flat surface, and threads were cut from the circular pieces. Beside being used for the manufacture of braided and wound cord, these threads were also used without covering, as a warp for making woolen and cotton stuffs elastic. It can, however, answer the latter purpose very imperfectly, compared with its use for the small articles that are less exposed to perspiration. It is well known that thread of native gum, such as here alluded to, soon loses its elasticity when exposed to perspiration, and also by long continused tension; which difficulties are obviated in the heated or vulcanized thread. The threads of vulcanized gum-elastic are cut with machinery very different from that used for the native gum, as represented in No. . They are cut from sheets of about a yard in width, of any thickness or length desired. This thread answers all the purposes for which that of the native gum was used, and many others for which the native gum does not answer at all.

When spun and twisted in a green or unheated state, before being vulcanized, this cord makes a very superior and durable article for fringes, tassels, &c. It will, for such purposes, possess the advantage over common stuffs, of durability, and not being liable to soil. It is also sometimes used for covering small phials and bottles, instead of vellum cord.

BRAIDED CORD.

The manufacture of elastic cord covered with cotton and silk thread, was established in France and England long before it

was attempted in America. It has been successfully prosecuted in those countries, where various useful articles have also been made and continue to be made from the native gum

The objections to the native gum do not apply to these goods with the same force as to articles in which the gum is not covered, because, as in the case of the McIntosh goods, the gum is protected from destructive agents by the various fabrics with which it is covered; the improvement of the vulcanized gum-elastic is therefore not so indispensable to them as to the other goods.

The method of manufacturing, is to wind or braid over the gum after it is cut into thread, with silk or cotton, by which bounds are set to its elasticity, and greater strength given to it at the point of its greatest tension. This is done by machinery such as has been long used for braiding whips, &c. This braid is ingeniously applied to the manufacture of braces, and of many small but useful articles, such as watch-guards, shawl pins, umbrella ties, &c.

ELASTIC CORDAGE

Is made of elastic compound. On account of the great difficulty, if not the utter impossibility of splicing or securing it by any fastening after it is vulcanized, it is necessary that it should be made up at the manufactories, into the articles for which it is used, with the fastenings attached. It might, therefore, be treated of as a heavier description of spring, with equal propriety as cordage.

This cordage is designed to be used in connection with hemp ropes or cables, to ease off the strain which would otherwise come upon them too suddenly. For further explanation see diagram, Vol. II., page

COVERED CORDAGE.

This is made of different kinds of thread, twine, rope, or annealed wire, according to the use for which it is intended. These are first coated with liquid compound cement, and then wound or rolled with a covering of vellum or tissue, tissue being used for the lighter, and vellum for the heavier kinds.

It has been suggested by nautical men, although it has not yet been proved by trial, that it would answer well for standing rigging, and other purposes on ship board. It is also designed for canal drag-ropes, seine twine, clothes-lines, and, briefly, for all uses where ropes are much exposed to wet, and where the first cost is not a consideration, which will, for this article, be greater than for common rope.

This description of cordage is used for some articles described hereafter, where great strength is required, instead of the cord composed entirely of vellum.

VELLUM CORD.

There are two methods of manufacturing this article: one is that of cutting either by hand or machinery, and rolling up strips of gum-elastic tissue or vellum into cord of any size desired. The other is that of pressing the vegetable leather of a suitable thickness, by grooved callenders, into cord of the size required. It has not sufficient strength to be used for many purposes by itself, without combining with metal wire, or flax, hemp or cotton twine. Its chief use is for the covering of glass and earthen ware, for the manufacture of cord ware, and other articles hereafter described among the numerous applications.

SPONGE CORD.

This article is of any size or shape required, and is made non-elastic when desired, by a cord or wire in the middle. It is manufactured either by cutting it from sheets of sponge fabric, or forming it with grooved calenders, or it may be more perfectly formed in moulds like hollow ware. Its most important, if not its principal uses, will probably be that of caulking between the planking and boarding of floors and vessels, and the making of trunks and packing boxes water and air tight, for the packing of doors and window-sashes, and coach and car window-sashes. See Vol. II., page

HARD COMPOUNDS.

Caoutchouc enamel. Ivory. Buck-horn. Whalebone. Boards. Veneers. Enameled ware.

Before it was found that gum-elastic and gutta-percha, in combination with other gums and resins, could be heated, so as to form a hard compound, the greater portion of this work was written and stereotyped. It was, however, felt that a substance was much to be desired which might be substituted for bone, whalebone, buffalo-horn, and ivory, (all of which are gradually becoming scarce,) and one which could be moulded like gum-elastic or gutta percha; and it was anticipated that if this object should be attained, great improvements in many arts and manufactures would probably result from such discovery. These anticipations have been more than realized, by means of a hard compound of heated caoutchouc. Although the manufacture is as yet no further advanced than to produce an assortment of specimens, their importance is evidently such that they deserve to hold a prominent place in treating of the properties of heated gum-elastic.

Owing to the difficulty of applying one term to these compounds, which will give a correct idea of their various properties, they are treated of as imitations of the following substances, namely, enamel, ivory, buck-horn, whalebone, etc. They not only make good imitations of these materials in appearance, but they are also in reality superior in quality, in some respects, to the natural substances.

The hardest of these compounds resembles marble;* that which is less hard, ivory and buck-horn; that which is still

* For the modification which gives it its extreme hardness, the writer is indebted in good part to his younger brother, Nelson Goodyear.

softer, buffalo-horn and whalebone; while they possess, in general, more durable properties than any of the substances above named, except marble, and they are even more substantial than that, in some respects; because, in all degrees of hardness, they have a great degree of toughness or tenacity, and the property of retaining the shape into which they have been moulded and heated.

Glass and the metals are too heavy for many small or light articles of convenience, too much so for some for which they are used Bone and horn are worked and finished with difficulty, while this material is worked and finished simply by moulding. Whalebone and ivory are every day becoming more scarce, and these also are manufactured with great difficulty and great waste, in comparison with this material.

CAOUTCHOUC ENAMEL.

This term is applied to this substance, because it is the hardest of all the hard heated compounds, and because the ingredients differ materially from those of the substances which are hereafter noticed as ivory and whalebone.

The process by which they are all made is the same. The principal difference is in the addition of a considerable portion of oxide of magnesia, iron, white lead, or other metal, with a larger proportion of sulphur in compounding the marble. It is somewhat more brittle than the India rubber ivory, and does not answer for all purposes so well, but it will unquestionably be found to answer, in many cases, where a substance is desired which is very hard, and yet not so heavy or brittle as porcelain or marble; it is not yet made so white as porcelain, but admits of coloring, moulding, and variegating, like the other hard compounds. The most important uses of this enamel are probably the plating or covering of iron furniture, coach and harness mountings, &c.

CAOUTCHOUC IVORY.

This material differs from the marble before described, in being compounded with less metal and sulphur, and not so hard; and yet it is solid enough to receive the finest polish. It is not affected, like ivory, horn, or buffalo horn, by being boiled in hot water, and resists the action of oils, acids, and other destructive agents, like glass. On account of the economy and facility with which it is moulded, the manufacture of it is not attended with waste of material like that of bone, buffalo horn, and ivory. The cost of it per pound is about the same as the cost of the other gum-elastic compounds, and it contains about the same proportion of gum-elastic as the vulcanized car-springs. To attempt to enumerate all the articles to which it is supposed it may be economically and profitably applied, is impossible and unnecessary. It is certainly well adapted, and perhaps better, all things considered, than any other substance, to make the handles of table cutlery, for the reason that they can be put on while in an adhesive state, and vulcanized so that they will not come off. It is also well adapted to make fine brush handles, fancy boxes, and numerous other articles that are now made of bone, buffalo horn, and ivory.

How far it may be substituted for veneers and fine wood, in the manufacture of musical instruments and fine furniture, and to what extent it may be applied to these and other uses, on account of its being more substantial, and not being liable to crack or warp by the changes of temperature, is a matter of curious inquiry.*

Many special advantages may be obtained from this substance, on account of the facility of uniting or cementing it as part and parcel with the softer fabrics, in the same way as peculiar ad-

* Some new and peculiar methods of using veneers of this material for furniture may be found Vol. II., Chapter , and also a novel method for the manufacture of musical instruments of this new material, Chapter

vantages are obtained from uniting or welding hard steel with soft iron.

This is exemplified in its use for the mouth of a bottle, the tube of a globe or life-preserver, where it is first cemented to, and afterwards vulcanized with the article, in which case it becomes a substitute for metal, far better than metal, because it does not corrode, and is perfectly joined, so as to form part and parcel of the article.

Some of the advantages anticipated from its peculiar properties, are alluded to as relates to various articles which are specified in the second volume of this work. For further explanation of the method of uniting the hard to the elastic and flexible fabrics, see Vol. II., Chapter XII., Military Caps; and Chapter XX., Skates.

CAOUTCHOUC BUCK-HORN.

The same substance which has been described as imitation ivory, makes, also, when pressed in moulds, a good imitation of buck-horn, which will answer all the purposes to which buck horn is applied.

CAOUTCHOUC WHALEBONE.

In the manufacture of the hard substances which have been described, it is not surprising that between the very hard compounds, or India rubber porcelain and ivory, and the very soft one of drapery, there should be produced a material which resembles whalebone very closely. This substance has the peculiar odor of horn or whalebone. The ingredients and proportions differ very little from those of the ivory; a greater degree of heat, however, is required in the manufacture of the whalebone.

There is good reason to suppose that this substance will be found to answer not only the general purposes of whalebone, but also those of horn and shell for hair and dressing combs, and other uses.

It may be made into sheets or forms of any size or shape desired, by moulding; for which reason it can be used for numerous purposes for which whalebone can not be used. The advantages which, from present appearances, may be anticipated with certainty in the substitution of this substance for whalebone, are the following, viz.: the quality of the caoutchouc whalebone is superior, the facility of working it much greater, besides the first cost being considerably less than that of whalebone.

CAOUTCHOUC DEAL BOARDS.

The ingredients of the compound and their proportions are the same for deal boards as for caoutchouc whalebone, and they are vulcanized with the same degree of heat. They are formed of alternate layers or sheets of the compound and cloth or canvas, until the desired thickness is obtained, commonly with the cloth outside upon one or both the surfaces of the board; or the board may be formed by coating the cloth, and afterwards splicing the different thicknesses together. A plastic wood or flexible board is thus formed, having the properties of caoutchouc whalebone, and on some accounts preferable to it, being cheaper for the same amount of bulk and strength; besides it can be worked or formed into articles after it is vulcanized, in some ways that the whalebone cannot, as it may be stitched or cemented together for boats, trunks, boxes, &c., on account of its being formed with cloth, and having cloth upon the outside.

CAOUTCHOUC VENEERS.

Perfect imitations of rosewood and other fine veneers are made from the hard compounds, and varieties of color may be produced such as are not found in any of the ornamental woods. They may be made without seam to any pattern; so that there is no waste in working in applying it. They are sometimes made with cloth on the back, which renders them strong enough for many articles, boxes, &c., without any frame-work of wood; in this case, however, especially where the cloth is a thick one, the substance might more properly be called caoutchouc pasteboard or whalebone. The superiority of these veneers is greatest where wood is most defective, since they are no way liable to warp or crack in the hottest room, and the facility and cheapness with which they are applied, together with little or no labor in finishing, renders the extensive use of caoutchouc for veneers a matter of certainty.

ENAMELED WARE.

This title includes a very large assortment of articles, such as carriage and harness mountings, and a great variety of articles of hardware, which are commonly plated, tinned, japanned, or covered with leather; and many articles commonly made of wood, earthen, porcelain, and glass. Various materials may be covered with caoutchouc enamel advantageously: by it iron is protected from rust, glass and crockery from breaking, and wood is rendered stronger and more ornamental. In the manufacture of enameled ware, the caoutchouc material is first applied in the green or plastic state to the iron or other foundation material, and the whole article thus combined is submitted to a high degree of heat, by means of which the materials are firmly united together and the enamel surface obtained.

CHAPTER XII.

PLANS OF THE INVENTOR.

The author adopts the plan of granting licenses to manufacturers, who stamp all articles made under the various patents with the author's name. Advantages and disadvantages resulting from the plan adopted. Remarks on the want of security to inventors by the present patent laws. New articles to be presented to the public. The utility of these articles in the advancement of education, and preservation of life, health and property.

It may seem to be of little consequence to the public to know what are the plans of an individual, but it may be of importance to him that they should be known, when their execution depends upon the co-operation of others. If they are reasonable and just, and the interests of others as well as his own are involved, especially if their utility be susceptible of demonstration, the interests of the subject may be advanced by their publication.

Enough has been said of the obstacles which were encountered in first bringing the discovery of vulcanized gum-elastic to the notice of the public, and in its successful application to the articles that were first made of the substance; but it is thought that justice to the subject demands that a statement should be made of the causes that have continued to operate, since the time of the discovery, against the progress of the art.

Previous to the discovery of the vulcanizing process before described, and for several years after the writer began his experiments, he entertained the idea of carrying on the business, and of establishing a reputation for himself as a manufacturer of gum-elastic.

Subsequent to the discovery, however, upon taking a survey

of what remained to be done to perfect the prominent fabrics, and extend the application of the discovery, the extent of which he did not, even then, fully understand, he abandoned the idea of all practical operations as a regular manufacturer, and has since that time confined himself, with a fixed purpose, to perfecting a series of improvements, embracing the various processes, and so far as possible, all the important fabrics and the most important applications of them, so as to form a connected system of inventions, and to render their application as practicable and perfect as the nature of the substance would permit.

In pursuance of this plan he has granted licenses under his patents, for some few branches of the manufacture, which were first appreciated, and with which the public were familiar. These branches have for the most part been conducted with credit, as well as profit, to the manufacturers, embracing in all, at this time, (1851,) some twenty establishments for the manufacture of heated or vulcanized gum-elastic, conducted by corporations or individuals, under his patents, with the stipulation that the stamp of the patent should be put upon the articles, as the patent law requires.

In consequence of this public use of his name, it has been erroneously supposed that he pursued the business as a manufacturer of the goods that are so stamped. This is a mistake which needs to be corrected. The whole manufacture, under these patents, is now conducted by licensees, in different parts of the United States, as advertised by them, and as the labels of their articles indicate. It would be the wish of the writer to pursue the calling of a manufacturer of gum-elastic, as a means by which he might hope to establish a better reputation for the manufacture than others will be likely to establish for it, did not circumstances conspire to prevent this; but he must content himself to leave the manufacture to be pursued by others, hoping to obtain such compensation from them as will enable him to devote the remainder of his life, (so far as feeble health and a constitution broken by too close application to the labors of experimenting will permit,) to making application of this substance to the use-

ful purposes and inventions, which would otherwise probably escape the notice and attention of others, as the original discovery might have done had it been sought after with less enthusiasm by the writer. The granting of licenses to others has been attended with much harm, as well as many advantages, in bringing the manufacture into notice. A great number of establishments, with means to operate, have accomplished much more in a practical way, within the time, than one individual with limited means could have done ; but on the other hand there was danger that the reputation of the invention would suffer from so many persons, unacquainted with the manufacture, being engaged in bringing it forward. Thus it has suffered much harm in various ways, and oftentimes the credit of the invention has suffered from a wrong or defective mechanical construction of the articles, when the quality of the materials were otherwise good. Articles of various sorts have been very imperfectly vulcanized, (many of which were made for the Government of the United States,) insomuch that the credit of the discovery, in some places, has been much impaired, or nearly lost for a time, and nothing but its real merit could have sustained it under such disadvantages. These, however, are accidents to which all manufactures, and especially all new manufactures, are liable ; for the writer there was no alternative but to introduce his inventions by the granting of licenses. On the whole, as the inventor anticipated, the good predominates ; the dangers which threatened have passed by, and there are now twenty experienced establishments engaged in the manufacture, where otherwise there would have been but one. By pursuing this course the inventor has been enabled to devote himself to perfecting the processes, inventions, and fabrics appertaining to the discovery.

In the further prosecution of his plans, a serious obstacle was presented by the conflicting of his views with those of his associates, as well as his counsel.

In the attempt to prosecute any enterprise, where there is a want of facilities for carrying it on, and especially an untried

enterprise, where there is a want of knowledge with regard to it, no obstacles are more directly calculated to hinder its success, than those connected with the differences of opinion between the projector of the enterprise and his associates.

In this instance, having observed the embarrassments of the inventor in consequence of his protracted experiments, the licensees engaged in the manufacture of those branches which were already appreciated, with the determination to avoid, as far as possible, all experiments. This was prudent as related to their pecuniary interests, but was a serious hindrance to the development of the whole subject.

Although the writer had taken the precaution to stipulate with the Naugatuck Company, which was the first company licensed, that they should manufacture the various articles which should be suggested by him for the purpose of developing the applications, and aiding to carry out his plans; the difficulty of making his views to bear upon the minds of others was such, that he was virtually compelled to relinquish the claim he had upon the company to do this. With kind intentions, no doubt, they, together with his other friends, earnestly deprecated his devoting more time or money to experiments, and constantly urged him to turn his attention to obtaining a pecuniary compensation from the branches already established.

The articles first manufactured of the new substance by these licensees, were suspenders, shoes, and elastics, with some descriptions of clothing. These branches were appreciated and engaged in sooner than other equally useful, if not more important uses of gum-elastic; for the reason that the public had become acquainted with their utility and value, by the previous use of the native gum for these purposes.

The manufacture of these articles being found lucrative to the licensees of the inventor, who assumed the business, they pursued it with a laudable enthusiasm. The whole subject, as might be expected, appeared to them to be embraced in those branches in which they were engaged. In their view, and that of the public, the invention was considered as complete, when it

answered the purposes to which it was then applied; while the successful application of the substances to these purposes, only gave assurance to the inventor that it was fairly commenced, and that these were but small items in the account of its utility, or the units in the sum of its value. Although, as now fully appears, the importance of those branches was in no degree overrated by them or the public, yet the proportionate value as relates to the whole invention was over estimated.

While the manufacturers were engaged with difficulties which are always to be encountered in rendering a new business productive, it could not be reasonably expected that they would enter very cordially into the plans of another, which could not be fully explained until they were further advanced, or forego the advantages which were certain to forward the wishes of another, when it was perfectly understood that the projector intended to reserve to himself the control and direction of those projects if they were successful. Consequently, the interests and the views of the inventor and the licensees became almost diametrically opposed to each other.

While the licensees were desirous of the inventor's co-operation in forwarding the branches of the business, which were already developed, and his counsel insisted upon the importance of his devoting his time and services for the defence of his legal claims, he deemed it of the first importance to complete his plan of improvement. It will therefore be readily perceived, that the very success of the discovery, as applied to the few articles that were perfected, presented one chief obstacle to the further development of the subject, and led them into the mistake of attributing the views of the inventor, and his persisting to continue his experiments, to an inveterate propensity for inventing, and a fondness for new things. He now hopes to be better understood, and to have attributed to him the wish to perform a duty which he felt had been allotted to him, rather than any desire for the unenviable distinction of an inventor.

Without assuming any thing, the writer may say that a comprehensive view of the subject was taken by himself; and, being

confident that no greater improvement could be made in gum-elastic than was wrought by the heating or vulcanizing, and the acid gas processes; and, as has been stated, relinquishing the idea of becoming a manufacturer, he became the more anxious to make such use of his opportunities as would enable him to complete a system of the inventions in gum-elastic, so that those persons who might in future assume to conduct the manufacture under his improvements, would at least have a field for extending a manufacture, in which they would not be exposed to impediments in their progress from subsequent improvements and patents by others, he having made it an invariable rule thus far, to put them in possession of all subsequent improvements of his own, upon the things licensed, without charge.

It has been a prominent object with the writer, to make this manufacture not only one of general utility, but of national interest in his own, as well as in foreign countries; and it has always been the intention of the inventor to introduce his improvements into foreign countries, when completed; the attempt to introduce them prematurely would have been prejudicial to his interests, and the completion of them in any other sphere than that in which they were commenced, if not impossible, would have been delayed longer than they have been by the hindrances spoken of. There was, therefore, no alternative for the inventor, but to persevere in his course under the disadvantages which have been stated.

It is believed that the series of improvements in gum-elastic, under consideration, are now so far completed, that when the facts and advantages connected with them are fairly presented and investigated by the public, the attention, skill and capital which is necessary, will be appropriated to them, and that this branch of business will be looked upon as an important and staple branch of industry, in all civilized countries.

The adaptation of gum-elastic, and many of the fabrics made of it, to military, maritime and naval purposes, is remarked upon in connection with the description of these articles. That they are of great value for many of these uses, there can be no

question ; especially is this the case in those countries where the navies and the armies are large. The nature of the substance makes it peculiarly adapted to those countries where there is the widest field for its appropriate use. Influenced by these considerations, the movements of the inventor have been governed in reference to preparing for its introduction into those countries.

The applications of a material like this, in all its combinations, to the various articles required for the use of the different departments of government, is an object that might well demand the efforts of a lifetime. It is, however, believed that the design of the writer to do this has been so nearly accomplished, that there is no sufficient reason for delaying longer a statement of his views; and also that the series of improvements in vulcanized gum-elastic is so far completed, that his purposes can be satisfactorily explained, and that what remains to be done can be accomplished with much less hindrance than has heretofore attended his efforts. The writer is fully aware that reasonable objections may be made to the extension of government patronage, and especially that of a republican government, to particular branches of industry ; and that it is deemed impolitic for governments to manufacture those articles which can be made by private individuals. The objections, however, apply more particularly to those articles which are used in common, both by the government and the people. But it may be said that it has been found expedient for governments themselves to make those articles which are needed only for government purposes ; not only such as ships and fire-arms, but also cordage and other equipments, made at their public docks and shipyards. Upon like grounds it may be urged, that many of the navy, maritime and military articles now made, and proposed to be made of this substance, are of a class demanded specially for government uses, and therefore deserving their attention.

If it is admitted that the substance is adapted to a small part only of the equipments, and other articles enumerated under the heads of maritime, naval, and military articles, and also that it is adapted to ships' sails, mail-bags, life-boats, and the general pur-

poses for which leather is used, the subject must address itself forcibly to all interested in affairs of government in any country. The articles before enumerated, and also carpeting, tissue, and vegetable leather, being made of raw cotton, in combination with gum-elastic, an additional argument will be presented to the government of the United States, in favor of its use, as connected with the great cotton interests of the South.

Individuals of the mercantile classes, finding it more lucrative to follow the demands of the market, are not induced to make experiments for government purposes; and, beside, they have generally less information respecting the wants of government, than the officers and engineers in its service. A branch of business like this, therefore, is not so likely to be developed for the purposes of government, without its special attention.

The writer cannot doubt that after sufficient opportunity for examination of the facts presented, the subject will obtain even from a republican government, that consideration which it so justly merits.

There is a portion of this subject in which the writer feels a deep and absorbing interest, and one to which he would be glad to devote himself in the evening of his life, should that be spared beyond its meridian, and also one which he would take delight in as a manufacturer; which is, its philanthropic and humane department, comprising articles for the preservation of life and property. There is danger, even now, notwithstanding all that has been done, that it will be too much neglected, in comparison with other branches of this manufacture, which, although perhaps more immediately available in a pecuniary point of view, are of much less importance. There is great danger that this part of the subject will not be sufficiently understood, and so far appreciated, as to be developed so that the present generation can be benefitted by it, as they otherwise might and should be. That the attention of the reader and the public may be drawn to this particular subject, I have classed all the articles under one head, that appeared to me to be of prominent importance in this

department of the business, in the chapter on "Articles for the preservation of life and property."

The inventor would here appeal to mankind in general, by affirming that there is no real necessity for such constant loss of life and property, by the sea and waters, as annually occurs. A proper investigation and public trial of the articles proposed, by a competent commission appointed for the purpose, will demonstrate the truth of what is here stated. What! must men continue to be drowned because their fathers were! must treasures continue to go to the bottom of the deep because there are offices where they can be insured! The loss to the world on that account is none the less, and such a state of things in the present age need not, and ought not, to exist.

The articles classed as educational, by which the cause of education may be materially advanced, as well as those belonging to the medical department, whereby suffering humanity may be relieved in numerous ways, deserve especial notice; and it is to be hoped that at no distant day the public mind will be roused to apprehend the importance of these inventions, and that when duly appreciated, the manufacture will be prosecuted, either by individual or public enterprise, with capital and energies commensurate with their importance. Nor is there any good reason to doubt that the manufacture of these classes of goods might be made a source of profit to those engaged in the manufacture, as well as a benefit to mankind.

CHAPTER XIII.

INVENTIONS AND PATENT LAWS.

"All things, rare or gross, own one common Father.
Truly spake Wisdom, There is nothing new under the sun:
We only arrange and combine the ancient elements of all things.
Invention is activity of mind, as fire is air in motion.
A sharpening of the spiritual sight, to discern hidden aptitudes.
From the basket and acanthus, is modeled the graceful capital:
The shadowed profile on the wall helpeth the limner to his likeness:
The footmarks stamped in clay, lead on the thoughts to printing;
The strange skin garments cast upon the shore suggest another hemisphere:
A falling apple taught the sage pervading gravitation;
The Huron is certain of his prey, from tracks upon the grass;
And shrewdness, guessing on the hint, followeth on the trail:
But the hint must be given, the trail must be there, or the keenest sight is as blindness."

PROVERBIAL PHILOSOPHY.

It is no easy matter either to ascertain or define what it is that constitutes an invention, or makes one an inventor, either in the eyes of the law or in fact. The law requires that in order that an individual shall be entitled to a patent, the thing discovered must be both new and useful. It is extremely difficult to determine what constitutes novelty, and also difficult to determine what is useful, before the invention has been submitted to the test of time and experience; as regards novelty, all that man can do is to form new combinations, and make new applications of substances and things that are old. It is a mistaken idea with many, that the invention of an improvement consists in the first vague idea of it. It takes far more than that to entitle one to the merit of an invention, for, between the bare conception of an idea, and the demonstration of the practicability and utility of the thing conceived, there is almost

always a vast amount of labor to be performed, time and money to be spent, and innumerable difficulties and prejudices to be encountered, before the work is accomplished; so that an individual who performs all that is necessary in these ways to bring an improvement to the notice of the public, and causes them to appreciate and understand it, by dint of perseverance, is on the whole in some countries considered the author of the invention, even though the first idea did not originate with him. It is worthy of remark, that the greatest discoveries usually afford their authors less remuneration than is obtained by others for trivial inventions. The more important the invention, and the more it interferes with previously existing modes of industry, the more are the public interested to dispute the claims, and infringe upon the rights of the inventor.

It is often repeated that "necessity is the mother of invention." It may with equal truth be said, that inventors are the children of misfortune and want; probably no class of the community, in any country, receive a smaller compensation for their labors than do inventors. A volume might be written in explanation of the peculiar difficulties and embarrassments to which they are subject, but the whole may be summed up in few words—as a general rule their labors begin, continue, and end in "necessity." Their hard fortune often calls forth the expression of pity and compassion from the public; while at the same time, there are too many ever ready to encroach upon their inventions, without their knowledge or consent. However valuable and important an improvement may be, it seldom happens that the rightful owners are benefited by it. There is, however, in such cases, one alleviating and consoling reflection to well-disciplined minds, which is this; success has crowned their efforts to do that which they attempted, and they can leave the world better off for their having lived in it. As with other classes of men, the case of one inventor will apply, with some variations, to the whole; he is impelled by a wish to gratify his inclinations, or driven by necessity to cast about him for some occupation to improve his condition, and fancies he has power of invention, and opportuni-

ties whereby he may open for himself a new field of action; and that, having accomplished his object, he will be guarantied by a patent, the exclusive enjoyment of his newly acquired property. In most cases, he knows but little of what he has to encounter, or the uncertainty of his reward. The thing he attempts may be foreign to his occupation, and he is obliged to resort to the mechanic or machinist, to obtain as he can, various parts of the thing he wishes to make; he usually finds it the most difficult thing of all tasks, to persuade other mechanics to do that for him which is novel to them, or of which they do not perceive the utility, and which they will most likely not perceive, if it is a labor-saving machine, or an improvement in their line of business. Oftentimes the plan is ever so well conceived, and the inventor and those he has called to his aid, have done their best in the execution of their work; it even then happens that the invention is a failure in the estimation of others, for the want of proper selection of materials, or from defect or oversight in its construction. Defeat only confirms him in his convictions that he is right, and he renews his attempts until success attends him, and he sees the machine which he has always seen to work in his "mind's eye," working to the admiration of himself and others. Hope revives, and for a time the satisfaction derived from the work is a full equivalent for the suffering he has endured. The individual has judged rightly as to his powers of invention, but he has little idea how much remains to be done to make the invention productive of profit; he has probably exhausted his own resources, and the resources and patience of his friends in completing his improvements; he has not the means to conduct the manufacture of his article, and without this he cannot so demonstrate the utility of his improvement, as to derive the advantage from it he expected. He takes the precaution to procure letters patent for his invention, which he counts as property, but which amounts chiefly to this, that the government grants him permission to fight his own battles. Next comes the Herculean task of convincing the public of the advantages of the improvement, and the yet more difficult one of supplying the

market with the improvement himself, and of preventing others from doing it by encroaching on his patent. If his object is to derive a profit by disposing of his patents for his inventions, it is well known that patents are so commonly evaded in some way, and that the patent law is so ineffectual for their protection, that the public will not value them highly, if at all; nor can they be expected to do so, for in too many cases the purchase of a patent is only equivalent to the purchase of a law-suit. If it be a discovery of unlimited importance and universal application, a thing of necessity in the community, the danger of the inventors losing the invention is increased in proportion to its utility and importance. There will be found persons in every community, unprincipled, and irresponsible enough to pirate the invention, especially if they can make some slight alteration and evasion of it. The community, especially at a distance, cannot always be expected to understand the merits of the case, or if they do, since competition gives them the thing they want at less cost, are apt to encourage encroachments for that reason: The thing, say they, is so simple that any one could have thought of it, and no one is entitled to the monopoly of thought. It would be far better reasoning, and certainly more just, to say that the inventor should be rewarded on that very account; because his improvement is simple, and therefore practicable; because he has avoided the great error in most attempts at improvements, that of complication and mystery.

Such is the inadequate security afforded to inventors for their rights, under the present patent laws, that unless the public are permitted, on reasonable terms, to participate in the advantages of an improvement, and above all, if it is one that brings about a great change in pre-existing manufactures, they will break into it, urging that no one has a right to supersede and thereby stop the progress of others, in their legitimate business, either by labor-saving machinery or other improvements. This reasoning is the more likely to be made use of, if the inventor is considered an innovator from another line of business. Every one is familiar with the feelings of operatives, when they are deprived

of employment by improved machinery, and it must be confessed there are cases of this kind, attended with evils enough, almost, to raise a question in the mind of the inventor himself, as to the benefit he confers on mankind.

The objectors are commonly not aware that changes of this sort are brought about so slowly, as to affect the immediate occupants of a branch of business much less than is usually supposed.

Poverty generally compels the inventor to part with a large interest in his invention, and then arises another great difficulty with regard to his patent, because the real property in an invention is not transferable; for while the art, in relation to its manufacture, is yet new, its chief value lies in the skill, knowledge, or reputation of the inventor; and unless the purchaser and inventor can subsequently harmonize, the patent is usually of but little value, either to the purchaser or to the inventor.

Another difficulty, as between capitalists and inventors, without regard to the men, is attributable to the nature of the business. The capitalist is often as incapable of managing an improvement, as the inventor is ignorant of mercantile business or practical operations, and these circumstances often render it impossible for the two classes to think alike, or harmonize together.

If the inventor has parted with a considerable interest in his invention, another serious difficulty immediately arises to prevent the parties realizing pecuniary profits from the patent. The public are apt to regard the purchaser of an interest in a patent, as a speculator, destitute of those equitable claims upon the public which they might concede to the inventor if alone; overlooking the material fact that the inventor has sold, and the purchaser has bought, a share in the original, *equitable,* as well as merely legal, business claims of the inventor. The public conscience is thus hardened, and the community, in the case of patents, witnesses with coldness and indifference, infringements of vested rights, such as would, in other cases, rouse its warmest indignation; and thus the inventor is deprived of the protection afforded

by those social barriers with which the sympathy and moral feeling of the community surround other rights of property.

The history of inventions as well as authors, with few exceptions, proves that whoever attempts by inventions to improve the condition of others, usually impairs his own, except so far as he may add to his happiness, from the satisfaction of having done good to others. A biographical collection of the lives of distinguished inventors, would afford interesting, but sad materials for the pen of an author. Among the unsuccessful, no case is calculated more to excite our sympathies than that of John Fitch, although his experiments should in no way detract from the merit of Fulton, his successor. Yet in the recollection of his sad fate, who can but wish that he might have lived to share in Fulton's success. Among the records of successful inventors who have made their improvements under the greatest embarrassments, and almost unparalleled discouragements, no one is more exciting than the well authenticated, though brief history of Paisley, the inventor of the methods of cementing porcelain. The case of Whitney, although not one of pecuniary privation, will afford a striking instance of inadequate compensation, compared with the magnitude of the results of his discovery, and the benefits conferred upon mankind.

PATENTS AND PATENT LAWS.

"History informs us that from time immemorial it has been the custom of monarchs possessed of absolute power, to grant monopolies of certain branches of trade. The abuse of this privilege, by reason of grants to favorites or unworthy persons, added to considerations arising from the intrinsic inconvenience and impolicy of such limitations of trade and industry, has rendered monopolies odious throughout the civilized world, and has led to the gradual diminution and final abolition of the custom wherever constitutions and equitable laws have prevailed."

"Patents for inventions are frequently, but erroneously, confounded with monopolies. A monopoly is a grant of an exclusive right to buy, sell or trade, in some previously existing branch of human industry. It is unjust and odious, because it takes away from the public, rights which they had, before such exclusive grant or monopoly existed. A patent is a temporary exclusive right granted to an inventor, to manufacture, use and vend his inventions, provided that he will first deposit in a public office a full and faithful description of every thing claimed by him as his invention. It is not liable to the accusation of injustice, because *it does not take away from the public any right which the public possessed before*, for it is evident that no such right could be claimed as part of an invention. Herein consists the essential difference between a monopoly and a patent; a monopoly deprives the public of previously existing rights, *a patent purchases for the public new rights which it did not possess before*, for a patent is a contract of purchase between the public and an inventor; the consideration given by the inventor is a full and faithful description of his, before secret, property or invention, with the public right to use it after a certain limited time; the consideration given by the public is an exclusive right to the inventor to use his invention for a limited time as a

compensation for giving a full and faithful description of his invention, so that it may be enjoyed freely, by the public, after the expiration of that limited time.

"The letters patent are granted upon the condition that the thing patented shall be new and useful. This puts the burden of the proof of novelty upon the inventor, and the expense attendant upon the production of the necessary evidence in a court of law, commonly renders the patent of little value to the inventor."

The imperfections and abuses, as well as the difficulties of administering the patent laws of most countries, so as to do justice to inventors, without doing injustice to the public, is a subject not sufficiently considered. The patent law is designed to reward the inventor or discoverer of an improvement by giving to him an exclusive temporary right to manufacture and sell all articles made according to the principles of his invention. The legislators who formed the laws, presumed that if the thing improved were a good one, it would always be patronized and paid for by the public, according to its merits; and that, therefore, by granting a patent, the laws themselves would give to the inventor the most equitable compensation for his labors. But the reverse of what was intended commonly happens.

The law guaranties to the inventor the exclusive right to manufacture, use and vend his improvements; which is the very thing, perhaps, that he has neither the means, the capacity, nor the inclination to do; and if he had all these in order to enjoy the apparent privilege, he is obliged to prove his title successively, in every judicial district, by a tedious course of law, against every infringer who chooses to challenge him by trespassing upon his patents, and who frequently, if not generally, derives the very means necessary to sustain litigation *from the profits of infringement,* thus, as it were, at the outset, *unfairly disarming the inventor and fighting him with his own weapons!* This is, to the inventor, a grievous hardship and wrong, and has no parallel in any other species of property. Possession of the field, and right to work in it, are given by law to the infringer,

the adverse claimant, the prima facie trespasser! Is not this a perversion of the natural order of justice? Ought not the inventor, who has received a patent only after severe adverse examination of his *claims*, by the patent office; to be secured in his exclusive right until his patent shall have been legally set aside, and declared null and void?

The English patent laws grant a patent to the man who first introduces or publishes the invention in England, without regard to the claims of the real inventor. This obliges the inventor to proceed with a great deal of secrecy in all his experiments, to avoid the danger of losing the invention by piracy; and oftentimes the law operates harshly, especially upon inventors in other countries, who desire to secure patents in England; but it makes a patent more valuable when obtained, and it enables the court to make decisions according to law, in which respect the English patent laws have unquestionably an advantage over those of the United States; for in general it is much easier to decide who first made a thing public, than who first conceived it, and performed the work necessary to constitute an invention.

For some years past a bill has been before Congress for the amendment of our patent laws, and it is to be hoped that ere long they will be so improved as to protect inventors more than they do at present, and give to their hardly earned rights a definiteness and security which are at present enjoyed by the more tangible forms of property.

Here are presented to the reader some just and forcible remarks of the Commissioner of Patents, Edmund Burke, Esq., upon the patent laws of the United States, found in his reports to Congress for the year 184–.

"In my former reports I have recommended a change in some of the features of the patent law as it now exists. For the nature of those recommendations, and the reasons on which they are founded, I would respectfully refer to the annual reports of this office for 1845 and 1846. In my judgment, the changes proposed are necessary to give adequate security to that valuable and meritorious class of our citizens engaged in inventive

pursuits. As the law now is, the remedies which it affords to patentees are, in most cases, inadequate to the protection of their rights, and the prevention of infringement upon them by that unscrupulous and unprincipled class of persons who make it a practice willfully to depredate upon patent-rights, and who, from the basely criminal character of the offence which they commit, are stigmatized by the appellation of the infamous epithet of pirate. Certainly, adequate protection should be given to the honest inventor who devotes his substance, and his incessant toil for the benefit of society, against the freebooters who invade, without scruple, his property, which, to him, is more sacred and invaluable, because it is the cherished creation of his own genius. But while his exclusive property in his invention exists, it must be conceded that the inventor has a right to demand of the government the most ample security and protection in its enjoyment. This security and protection he does not, under our present imperfect system, enjoy. On the contrary, the difficulty and expense, and the absolute impossibility, in some cases, of vindicating his rights, have rendered the present laws enacted for his protection, almost absolute nullities. To remedy this imperfection in the existing system, is the object of the amendments of the patent laws, proposed in the two former reports of the undersigned.

"It seems unnecessary to remark upon the incalculable value of the labors of the inventor, and his claims upon society for protection in the enjoyment of his just rights. And sooner or later, the undersigned is confident they will be fully recognized and protected by the enlightened legislators of a great Republic, whose progress has been so much accelerated by their genius and enterprise."

The writer of these pages has not the presumption to present any plan of legislative action as a remedy for the evils which are universally admitted to exist under the present patent laws. The matter demands and deserves the serious consideration of the most experienced and able legislators. Is this subject too difficult for the human intellect to master, or for society to settle

upon an equitable basis? Can not a system be devised, which shall, on the one hand, interfere to the least possible extent with liberty of public industry, and shall, on the other, secure to the inventor a fair reward out of the fruits of his labors?

If, as must be admitted by all, the difficulties are so many in the way of securing to inventors their legal rights, and if the expense and perplexity of defending patents is greater than the advantages conferred by them, and if the author of the inventions treated of in this work is aware of all this, the question may be asked, why has he availed himself of the patent laws to secure *his inventions?* A satisfactory reason, it is believed, has before been given, which is, that during the progress of his experiments he received pecuniary aid from others, stipulating with them that they might avail themselves of a portion of such advantages as might be derived by obtaining patents for these inventions. The protection which is afforded by letters patent to important inventions unquestionably is far better than none at all.

When any important discovery is made and patented, embracing numerous inventions, and when the subsequent improvements which render the discovery completely successful are patented by the same inventor, as in the case of vulcanized gum-elastic, such patents, if they do not guarantee a complete monopoly of any particular branch of business, give to the patentee the right of action against infringements, and it would be unsafe for the capitalist to engage in the same business while this right of action was in the hands of others. Besides there is at least a satisfaction in holding a just claim to a discovery under the present patent laws, uncertain as they are, in hopes that they may be made better, even if they are trespassed upon with impunity to a limited extent.

Although the penalty of violating a patent is not so certain of infliction as to prevent unprincipled or irresponsible persons from pirating an invention, yet the liability to prosecution is such that men of capital and character will not be tempted by the profits of a business, to engage in it, to contend with others possessed of capital, who are the owners or licensees of a

patented invention. There is therefore much in favor of those whose business is made in any good degree exclusive by a valid patent, and little hope of success in the same business for those who infringe upon or attempt to break the patent. If the object of the infringer is to break down a patent, he commonly finds it a fruitless undertaking, for if he succeeds in doing that, he does not thereby gain any exclusive advantage for himself, but he breaks the patent at his own expense, and throws it open for the benefit of the public at large.

Such a policy is obviously short-sighted ; for, to say nothing of the injustice of the course as relates to the inventor, or those who honorably and fairly purchase of him, it is not the best course for the individual desiring to possess himself of the same advantages, or to participate in an improvement. It is far cheaper for any one engaging in a new business to pay to the patentee a fair consideration for a license, and to have fairly imparted the knowledge which the experience of the inventor has necessarily given him, rather than attempt to gain the same information by experiment and usurpation.

THE

APPLICATIONS AND USES

OF

VULCANIZED GUM-ELASTIC;

WITH

DESCRIPTIONS AND DIRECTIONS FOR MANUFACTURING PURPOSES.

BY CHARLES GOODYEAR.

VOL. II.

NEW HAVEN:
PUBLISHED FOR THE AUTHOR.
1853.

CONTENTS.

VOL. II.

APPLICATIONS

CHAPTER I.

EDUCATIONAL.

CHAPTER II.

CARPETINGS, TENTS, AND AWNINGS.

CHAPTER III.

COVERINGS AND SPREADS.

CHAPTER IV.

HOUSE, SHIP, AND CAMP WARE AND UTENSILS.

CHAPTER XI.

NAVAL AND MARITIME.

CHAPTER XII.

MEDICAL AND SURGICAL.

CHAPTER XIII.

PHILOSOPHICAL, OPTICAL, AND MATHEMATICAL INSTRUMENTS.

CHAPTER XIV.

MUSICAL.

CHAPTER XV.

GYMNASTICS AND CALISTHENICS.

CHAPTER XVI.

TOYS AND TRIFLES.

CHAPTER XVII.

SPORTS AND GAMES.

CHAPTER XVIII

SPORTING.

CHAPTER XIX.

HORSE TRAPPINGS.

CHAPTER XX.

HARNESS.

CHAPTER XXI.

STAGE COACH AND CARRIAGE TRIMMINGS.

CHAPTER XXII.

FANCY AND ORNAMENTAL USES.

CHAPTER XXIII.

AIR-WORK.

CHAPTER XXIV.

MISCELLANEOUS.

CHAPTER XXV.

APPENDAGES OF WEARING APPAREL.

CHAPTER XXVI.

WEARING APPAREL.

CHAPTER XXVII.

BATHING APPARATUS.

CHAPTER XXVIII.

TRAVELLING APPARATUS.

CHAPTER XXIX.

LIFE-PRESERVING TRAVELLING APPARATUS.

CHAPTER XXX.

ARTICLES FOR THE PRESERVATION OF LIFE AND PROPERTY.

APPLICATIONS.

Of heated or vulcanized gum-elastic. Its usefulness and variety. Novelty and peculiarity of construction, and the necessity of detailed descriptions. Extent of application. The words India rubber, gum-elastic, caoutchouc, synonymous throughout this work.

In describing the applications of caoutchouc, the writer has endeavored to confine himself to the description of such fabrics and applications only as are deemed to be of practical utility, though in some few instances articles are described which have not been tested by use at the time of writing.

Reasoning from the utility of other things like them in kind, it may be fairly presumed that they are alike useful. Where there is a doubt of the success or usefulness of any application, the fact is stated in connection with the description of the article.

Had not the writer confined himself to rules of this sort, or had he indulged in describing uses and things deemed of possible or probable utility, or even described all the varieties of the same class of articles, or enlarged upon all the ascertained uses of successful applications, it would have swelled the volume to an inconvenient size. To those who are unacquainted with the subject, or who have not seen the specimens, there are some applications mentioned, such as clothes-brushes, coal-scuttles, kitchen utensils, &c., which may at first appear ridiculous. Notwithstanding this, it may very likely be found that these are the very articles to which some of the fabrics are best adapted. In the description of the various articles, it is stated that each article is made of one or more of

the different fabrics, or of a variety of them. The writer does not mean to say, that in all cases the articles will hereafter be made of the same fabrics, and by the same methods which are at present adopted; but that thus far such fabrics are found best for such uses, and that the specimens are now made of such fabrics and upon the plan described, which in most cases, it is believed, will be found at any future time to be the best method of manufacture.

In nearly all cases where drawings are given, there is some novelty in the article, or some peculiarity in the construction, on account of which they are thought necessary to the description, in order that all may understand them. Among the applications there are included quite a number of inventions made by other individuals, for the successful operation of which, these fabrics have been found necessary. He has given the names of inventors in all cases where he has been able to ascertain them, and has placed his initials to those inventions only, which he believes to be exclusively his, omitting to do this in cases where the original ideas were suggested by others, notwithstanding that they were wholly demonstrated by himself. If the applications appear too numerous to have been made by one individual at one time, it will be remembered that the labors of fourteen years are herein summed up. This work is not made of speculative theories and specifications of things supposed possible to be done, but it consists principally of facts fully demonstrated by actual experience.

Although it will be impossible that the various markets can be supplied with many of the articles for a long time to come, yet any or all of them can be obtained by specially ordering them from the respective licensees of the inventor, according to the branches which they have severally undertaken to prosecute. It may be thought, by some, that there is an indiscriminate recommendation of the different fabrics, for different uses, but such is not the fact. It is believed that in most, if not in all cases, there is a good reason for the selection and recommendations made of particular fabrics for particular

uses, though the reasons are not always given for the selection that is made.

During the course of experiments which occupied five years, previous to the discovery of the vulcanizing process, and two years subsequently to it, new uses and applications of gum-elastic were almost constantly discovered, and the substance with which the writer experimented, was indiscriminately applied to different articles, as convenience and fancy prompted, for the purpose of testing the quality of the gum, and the success of the experiments. In this way a more thorough knowledge was acquired of the nature and susceptibility of the substance, so that when his efforts were crowned with success, and there remained no doubt that a valuable improvement had been made, and there was no longer any danger of failure from the decomposition of the gum, the inventor was well prepared to go forward and extend the applications of the improvement indefinitely, until the question came not to be, How far can they be extended? but, Where is the limit?

A large proportion of the fabrics, and a great number of the applications and newly invented articles have never, until now, been presented to the public. It is to be expected that a portion of the community will consider some of these things simply as novelties, too uncertain to be represented as articles of utility; but it may be remarked, they are not novelties to the author. Many of them have been experimented upon and tested by him for years, in various ways, although it is true the greatest share of them have been but recently perfected. Among the most recently invented fabrics are the fibrous and plated fabrics, the napped, porous, corded, perforated, and indelible fabrics, cord-ware, hollow-ware, and sponge goods, improved air-work, the quilted and ventilated fabrics, and the various hard compounds—caoutchouc enamel, whalebone, buck-horn, and ivory. These, together with the recently perfected and most important applications—ships' sails, globes, carpeting, umbrellas, and life-preserving trunks, and bags, have been withheld for *the purpose of being perfected*, and also to be made public subsequent to the completion of this work.

With regard to the inventions and applications of his own. which are marked with the initials of the inventor, he deems the greater part of them of little importance in comparison with the original discovery, through which, alone, all the subsequent applications and inventions are rendered useful, or in comparison with the fibrous and plated fabrics which he considers exceedingly important in a mechanical point of view, as many of the fabrics, and a great number of the articles which are designed as substitutes for leather articles, could not be made to advantage in any other way, on account of the gum peeling off the cloths and canvas on which it had been spread. It is for this reason that the woven cloths, coated with gum, are not recommended for a greater number of uses. The reason why they are recommended in some cases is, that in the present state of the manufacture, they may be more conveniently made or obtained than the improved fabrics.

Since the properties of the heated or vulcanized gum-elastic and the qualities of the fabrics are becoming better known and appreciated, there is a growing interest in the subject which has drawn the attention of many inventive minds to the application of the substance and the various fabrics, to numerous arts and manufactures, which come within the sphere of their operations. Among the useful inventions made by others are Ship Lights, by Mr. Hidden;* Spring Shoe Clogs and Hydrant Faucets, by Dr. C. Stearns; † and Car Springs, by Mr. F. M. Ray.‡ Many others have since been made. These are alluded to as being among the earliest established manufactures. From the complete success of these various inventions the future success of others may be anticipated.

To enumerate all the articles which it is believed may be advantageously made of this substance, would swell the catalogue itself to a volume. It would include a great proportion of the articles in common use. The writer has selected and described from some of the classes of articles those only which were most prominent. For instance, among the articles or utensils which

* New York. † New York. ‡ Springfield, Mass.

have heretofore been commonly made of metal, tin, earthen, or pasteboard, almost the whole range of those wares might have been given with equal propriety, at least for specific uses. It is not, however, asserted that these articles, when made of gum-elastic, are to be preferred to the same articles made of other materials, except in particular cases. Neither is it supposed that they will become generally substituted for articles made of glass, earthen, or metal, or lessen the consumption of articles of that kind; but it is maintained, and the articles that are made prove, that for special uses and occasions, they have a peculiar merit.

Notwithstanding the novelty or apparent absurdity of applying gum-elastic to such uses, objections are usually removed when the articles or specimens of them are examined.

Although a large number of articles are classed under the different heads to which they are commonly considered to belong, a great many articles may yet be added to most of these classes, and particularly to the following: House, Ship, and Camp Utensils; Miscellaneous Articles; Toys and Trifles; and Springs. For this reason the chapters are left open.

As a general rule, where few articles of a class are noticed, those are described which were thought most defective in some particulars, as they have heretofore been made of other materials, or of such things as might be most improved by some peculiar property of the new fabric or compound recommended for them.

For instance, ewers are noticed among the chamber ware, because when made of crockery they are so liable to be broken, and to be cracked when water is left to freeze in them. Coal-hods among kitchen ware, because sheet iron hods are noisy, and soon rust out. Dolls, quadrupeds, and birds among toys, because they are so easily made to imitate the different noises natural to each. Others again are noticed for the reason that they can be made more portable of gum-elastic than of other materials. A variety of uses of this substance are perhaps as deserving of notice as those which have been mentioned, and many uses of it will undoubtedly be suggested by different individuals in connection with the different occupations and pro-

fessions in which they are engaged. They, will also unquestionably discover advantages relating to some things which are described, which the writer has omitted to notice. In all cases, however, where he has knowledge of objections to their use, he has not hesitated to point them out.

The impervious articles among wearing apparel, have been particularly noticed for the purpose of pointing out the objections, as well as the valuable properties, of gum-elastic for such uses; while the wearing apparel which is pervious to air, and yet impervious to water, may be much more deserving of notice in many cases; though little will be said in reference to them, until it can be better ascertained how far this double property of these fabrics can be applied, and made available in the use of caoutchouc. It may, however, be remarked, that the uses, as well as the value of India rubber, will be vastly increased by the introduction of the recently invented fabrics already alluded to, and particularly the wool-napped, plated, and corded fabrics and hard compounds, and also the porous fabrics, as in them the objections which have heretofore been considered insurmountable, viz., confinement of perspiration and the exclusion of air, are overcome.

In attributing to other individuals some of the inventions hereafter described, the writer does not vouch for the facts, but gives them according to the best of his knowledge.

The words caoutchouc, India rubber, and gum-elastic, are used as synonymous throughout the work.

CHAPTER I.

EDUCATIONAL.

Bound paper. Art of book-binding. Book-binding, or covering. Outline maps. Maps. Embossed maps. Illuminated maps. Framed maps. Charts. Globes. Outline globes. Sectional globes. Incompressible globes. Blank globes. Embossed globes. Illuminated globes. Self-inflating globes. Black and white-board. Slate and memorandum paper. Slate and pen-wiper. Inkstands. Improved inkstands. Inkstand packing. Artists' India rubber. Pencil-heads. Rules. Portfolios. Desk covering. Map carpets. Pens. Pencils and crayons.

The importance of the improvements in gum-elastic for educational purposes, have been briefly commented upon in the first volume of this work, and they will also be briefly alluded to in the description of the articles in this chapter. More might be written upon the subject in regard to most of them, and too much could not well be said in commendation of others. Much remains to be done to perfect them, but enough has already been done to prove that the cause of education will hereafter be promoted by the use of many articles made of the vulcanized fabrics. The cheapness of some of the articles, compared with those made of other materials, gives double assurance of the correctness of this view. The expensiveness of globes, which are admitted by all to be by far the best means of imparting and obtaining geographical and astronomical information, has rendered them accessible to few persons, either pupils or teachers. The adaptation and application of gum-elastic to these purposes, will bring within the reach of every pupil in every common school, a perfect globe, at a price within their means ; or maps more durable than leather or parchment, at cheaper rates than paper maps are

now made when mounted upon muslin. Some of the articles described in this chapter more properly belong to the department of stationery, and others are only articles of accommodation or convenience for schools; but for the sake of conciseness, and to give a comprehensive view of the whole, they are all treated under the head Educational.

By allusion to two improvements of modern times, one in stationery, the letter envelope; another, the method of teaching with outline maps, the public may better appreciate the value and timely introduction of the two improvements described in this Chapter, caoutchouc bound paper and illustrated outline maps, and map carpets.

The advantages of the method of teaching geography by the use of outline maps was apparent, and the system was partially introduced by the use of paper maps, previous to the application of caoutchouc to this use; but their cumbrous bulk and liability to damage, beside their expensiveness when mounted on muslin, presented an obstacle to the progress of the improvement in this method of teaching geography, so that a suitable material upon which to print these maps, became a desideratum. The timely application of gum-elastic tissue and vellum to this use, meets the necessity of the case.

The binding of paper, as hereafter described, is another improvement, the demand for which is the more imperative, in consequence of the introduction of the letter envelope, which has recently come into general use, and which has become almost indispensable for the comfort and convenience of every one who has any considerable correspondence. This change in the use of paper for letter writing, demands a corresponding change in the method of putting it up for the market; and it is believed that the requisition is met in the article of bound paper.*

* As early in 1836, a medal was awarded to the writer by the Mechanics' Institute of New York, for the application of India rubber to the art of printing. The effort to make the invention practical and useful, has been continued until the present time. The views that were then entertained of the importance of the art may now be appreciated.

BOUND PAPER.

The method of binding paper, which is referred to in the heading of this chapter, is an improvement which combines economy with neatness and convenience. A coat of gum-elastic cement is applied to the edges of the paper on the back of the ream, and over it a sheet of thin gum-elastic vellum for the purpose of a binding. Quire marks are also bound in between the quires or half-quires; these are either bits of tissue paper or a sheet of paper of another color. It is made yet more convenient at a trifling extra expense, when sheets of blotting-paper are bound between the quires. By this method of putting up paper, the separate quires in the reams are always kept in their place; each sheet is kept in its place in the quire until wanted, and every inch of paper left in using parts of sheets, is kept bound until taken out; and while the quire is being used, there is but one half sheet outside or underneath to get soiled. A much more important item in the account of its convenience and utility is, that when a sermon, deed, contract, or other article is written upon the quire, which requires a greater or less number of sheets, the pages may be written consecutively until the deed, or other document, is finished; and when cut from the ream, the document becomes a bound book of the strongest kind, so far as holding the sheets securely is concerned. The delay and inconvenience of stitching or fastening a document with eyelets is not encountered, which, by the common method, has to be done, if at all, at the last moment of executing a document, when it is most inconvenient, and persons are in the greatest haste. The document bound in this way will lie open where it is desired when laid down, and does not give one trouble by its constant shutting; beside, there is a saving of from one to two inches of paper, because it may be written upon quite to the top of the sheet, there being no margin required, as in the case of fastening by stitching or eyelets. The convenience in the use of this paper

may be aptly compared to that of the letter envelope; only the improvement may be said to be as much more important as the consumption of writing paper is greater than that of paper for envelopes.

It is reasonable to suppose that in the first manufacture of cap and letter paper, it was folded chiefly for the following reasons: first, that it might be used in the form of a book when the sheets were stitched together at the back; second, that it might be conveniently retailed by the quire; and, also, in letter writing, that the half sheet written upon might be folded in the other half as a wrapper. The bound paper will be found preferable, in all these particulars, to any before offered to the public. In a brief correspondence, when folded paper is used, there exists the necessity of remitting a half sheet that is not required, or of sending the correspondent a torn half sheet, either of which is objectionable: both these objections are avoided in the use of the bound paper, the sheets being put in the market without folding, of any size required. It is probably not very far from the truth to suppose that as much writing paper is wasted as is necessarily used. The use of a few quires of bound paper will satisfy any person that, in addition to the satisfaction it otherwise gives, a large share of this waste may be avoided.

ART OF BOOK-BINDING.

Some method by which books could be more securely and expeditiously bound, has long been desired, both by publishers and the public. By the use of the vulcanizing process, this object is now attained, and specimens are produced, both with the ordinary bindings, and the vellum and tissue bindings hereafter described, together with the book covers, which it is believed will satisfactorily demonstrate the value of these improvements.

The writer does not pretend that the idea of binding books by means of India rubber originated with himself. It was first

attempted many years ago in England, and it was also attempted in the United States as early as 1836, but it is well known that India rubber, not vulcanized, is too perishable a substance for any such application. The result has been that such attempts, after producing considerable excitement, and raising the expectations of the public, have proved failures. In this instance a very different result is anticipated.

One of the inconveniences attending books bound in the common way, is the difficulty of holding them open so as to be read at the inner margin; and the same remark applies to blank books, with still greater force, in regard to the difficulty of writing up to the back, until the backs are sufficiently broken or worn to admit of it, by which time the leaves are usually so loosened as to fall out. By this new method of binding, this difficulty is completely overcome, so as to admit of the book being opened quite flat and level. The writer believes that it is not saying too much, to affirm that books bound in this way will possess a great advantage over books bound in the usual way, on the score of durability. This improvement is applicable alike to printed and blank books, and although the expense of binding each is less than by the common method of binding with glue and stitches, yet the saving of expense will be greater, and the advantage more apparent in blank books than any others, except it be music books. In addition to the foregoing, an improvement has been made by the writer in the manufacture of covers for expensive books and ledgers from caoutchouc whalebone, with elastic compound for the backs, which it is believed will be found more durable than any heretofore made of other materials.

BOOK-BINDING OR COVERING.

A fabric is made of vulcanized gum-elastic tissue and vellum, for cheap publications, and of gum-elastic corded vellum, of different thicknesses, made in imitation of Russia leather, calf skin, and morocco, for more valuable works. The superiority of

this material as a binding or covering for books, consists in this, that it does not crack or warp, is not injured by worms, water, or oil, is not easily soiled, and is readily cleansed when soiled. Beside, it admits of every style of ornament in the highest perfection.

When finished in the style of the indelible fabrics, described on page , or gilded, it admits of all the elegance of execution, and possesses all the durability, that can be desired in a book cover.

Admitting that these fabrics possess the advantages for bookbinding that are claimed for them, another and a great recommendation will be their cheapness and economy; as those which are designed as substitutes for morocco, calf, and Russia leather, may be afforded at nearly the same price as cambrics and paper, and at about the price of the cambrics now used for binding.

OUTLINE MAPS.

These are printed upon the vulcanized India rubber fabrics, both transparent and opaque, and also upon various articles to be used for other purposes besides maps, such as piano-covers, crumb-cloths, and carpets. Arrangements are being made foı this manufacture, which may facilitate the method of teaching from outline maps, by printing on this material maps of the world, upon a scale large enough for papering the sides of an ordinary sized room of a school-house, academy, or public lecture-room or dwelling. The same map, when suspended at a suitable distance from the wall, with lights placed behind it, may be used as a transparency for teaching at night. A series of sectional maps, printed on a scale as large as can be conveniently printed upon callenders, after the manner of calico printing, are cemented together and arranged upon rollers, as represented in plate ii., so that they may be passed from one roll to the other. With the map of the world before the pupils or audience, the

geographical position of each state or country may be readily explained, and it is obvious that by the use of such a series of maps as a transparency, together with the map of the world, and the illuminated globe, the study of geography may be taught with a great saving of time and expense, and may also be taught to those whose sight does not admit of close study at night, as well as those who have no leisure hours to devote to study except at night. The perfection of this system, however, will not be attained until skillful artists shall have turned their attention to the subject, for the purpose of illustrating the maps by the best designs, and most truthful representations of the scenery, productions, and costume of the inhabitants of the different countries, and blending these with the geographical outlines.

The panoramic representations, so popular of late, are proof of the interest that may be given to a panorama of the world prepared in this way, for the teaching of geography and astronomy, now too much neglected for the want of such facilities.

When the plates or callenders are once executed, the printing of these maps will be no more expensive than the ordinary printing of calicos, so that sets of these maps will be brought within the reach of any individual or institution, that can afford the expense of atlases or maps of any kind. Outline maps for the use of schools, printed upon this material without illustration, are already offered for sale by the licensees of the inventor; and also crumb-cloths, table-spreads, and piano-covers, with maps printed on them; it having been proved that these impressions, with the coloring, are sufficiently durable for these purposes, not excepting carpeting, which is exposed to hard service.

MAPS.

These are printed upon vulcanized India rubber, vellum, drapery, and tissue; drapery being used for pocket maps, and vellum for those that are mounted. The advantages over paper which are

claimed for maps of this sort, are very many. They possess an intrinsic value for many other purposes besides those of instruction. They may be used with impunity as table or bed spreads, or, in fact, as common crumb-cloths ; they may be doubled and folded any number of times, and handled without care ; may not only be washed, but also boiled in hot water or soap suds, without injury to the goods or to the printing. They are useful for schools, as they can be brought to the desk of the pupil, instead of his being compelled to climb to use them. In order to demonstrate the utility of the fabrics for this use, the plates of this work are printed on the fabrics, and the maps are executed both in lithograph and copper-plate printing. It is deserving of special notice, that the water-colors, as well as the print of these maps, are indelible.

EMBOSSED MAPS.

Gum-elastic maps may be so embossed in the manner in which hollow ware is made by engraved moulds, as to show the elevations and depressions of the earth's surface. The article may be made as elegant as the foreign article of this sort, made of pasteboard, and durable as *caoutchouc*. Beside the general geographical correctness and utility of embossed maps, the subject is one of philanthropic interest, concerning the well-being and happiness of the blind.

ILLUMINATED MAPS.

Gum-elastic maps, when made of transparent tissue and illuminated, may be profitably used for instruction at night ; and likewise large outline maps for illustration of lectures, &c. For further explanation relating to this class of articles, see transparencies, illuminated globes, &c., page

FRAMED MAPS.

The various kinds of gum-elastic maps may be framed with the same material, and inflated with the self-acting valve tube, as represented in plate , fig. . When gilded or bronzed, these aerial frames resemble very closely the wooden gilded article ; and when collapsed, they occupy very little space. Maps framed in this way may also be used as bathing mats and carpets for children, without injury to the engraving or coloring, while the increased expense of the map on account of the frame is very trifling.

CHARTS.

Are made of vegetable leather, or what might for this use be properly termed gum-elastic parchment. The same general remarks that have been made in regard to maps, will apply to charts. They also possess another superior quality, which is particularly requisite for charts. The dimensions of this parchment do not vary like paper when damped for printing; in like manner the dimensions of these charts do not vary from change of atmosphere. They may be exposed to wet, and to salt water for any length of time with impunity. The vessel's course can also be marked on them with pencil or ink, and afterwards washed off, if desired.

GLOBES.

The globe has heretofore been so expensive as to be found in schools only of the higher class. No form of map or atlas can

give so correct an idea of the surface of the earth, or of the relative situation of places, as a globe. One of three feet in diameter may be made a complete atlas.

An attempt to make them of gum-elastic was made by the writer soon after the discovery of the acid gas process. Specimens were at that time made of the pure sheet gum, cured by the acid process.

These attempts have been followed up at intervals, until the present time. They have been made of the knit goods, coated florence, and the plated fibrous fabrics. On many accounts, the last-named fabric and sheet gum may in general be best for this use. They are made of various sizes, and when embossed by the method described in the manufacture of hollow-ware, they may be made to supply the present deficiency of globes for the blind.

The utility and importance of these globes to the cause of education must be fully apparent, when it is understood that any child can be furnished with a perfect globe at a price to come within his means. When used, these globes are inflated with air, and when collapsed, may be folded in so small a compass as to be no incumbrance under any circumstances. When the large sizes are filled with hydrogen, they become a highly ornamental and beautiful object.

A convenient method of arranging those that are filled with air for use, may be seen from the plate, fig. 1; suspended from the ceiling, by a cord running to it from the side of the room, fig. 2, or by its axis, like other globes. Another convenient method is to place the inflated globes upon a light hoop stand, or a suspended hoop, figs. 3 and 4.

OUTLINE GLOBES.

After what has been said on the subject of outline maps, comments upon this article are unnecessary, except to say that the same general remarks will apply to globes as to maps.

SECTIONAL GLOBES.

Sectional globes, as represented in the diagrams, Plate , figs. are made from caoutchouc boards or whalebone, which is coated with India rubber tissue or elastic compound. The sections are fitted into the edges of the polar circles or discs, which are formed with grooves to secure them in their several places. When the sections are matched together, before they are fitted to both the polar discs, they are fastened together at the equator by a caoutchouc whalebone hoop, which is slipped into catches upon the sections on the inside, and also by an axis passing through the globe and fastened at the poles. This method of manufacturing globes from gum-elastic is the invention of another.* They may be easily taken apart, and combine the firmness of the ordinary pasteboard or plaster globes with the compactness and portability of the flexible ones which are made of India rubber.

INCOMPRESSIBLE GLOBES.

The only question which has been raised as to the utility of caoutchouc compressible or inflated globes is, whether they can be made firm and exact enough to be mounted for working problems with as much precision as the common plaster globe.

If this be granted, the objection may be removed by making the shells and horizon of caoutchouc whalebone covered with printed India rubber tissue, instead of paper, and the frame of caoutchouc-ivory. Globes made in this manner will be lighter, stronger, and as exact for the working of problems as the plaster globe.

* Charles Goodyear, Jr.

BLANK GLOBES.

This invention was suggested by another.* The article may be made of the gritted fabrics, tissue, or vellum, and its use may be deemed very important for instruction in drawing, as globes may be drawn upon them by the pupil with the pencil and pen, or with the brush and paints, and afterwards either washed off, or fastened on the globe by means of any transparent varnish.

EMBOSSED GLOBES.

These are made of gum-elastic compound, in the same way as hollow ware, and have been before alluded to in the account of that manufacture. These may be said to be much more substantial and durable than wood and plaster, so much so, that they may be used safely as bat and foot balls; and after the first outlay of capital for moulds, &c., the cost of the manufacture will not be greater than for other bat and foot balls, aside from the expense of coloring, which may be done by inking in the moulds in such colors as will stand the heat at the time they are vulcanized.

ILLUMINATED GLOBES.

These are made of gum-elastic tissue and vellum, in the same manner as the globes already described, except that they have a funnel made of the same material, which passes through the globe, and which is cemented to it at each pole; in the middle of the funnel is secured a fixture or cross bar, on which a lamp may be placed. The globe is thereby illuminated and becomes highly ornamental as well as useful for study at night. Although it may be turned round, it cannot be turned over with safety.

* Mr. Henry Barnard, of Hartford, Conn., for many years superintendent of the State schools in Massachusetts and Rhode Island.

SELF-INFLATING GLOBES.

All the different kinds of flexible globes described, may be made self-inflating by suspending them from the top or north pole, when they are hooped on the inside. This is done by a series of hoops, which may be made of wood, metal, or caoutchouc whalebone, according to the size of the globe, and the materials of which they are made, the hoops lessening in circumference from the equator north and south, as they approach the poles, each globe requiring about seven of these hoops; they are covered with tissue, and cemented to the globe on the inside during the process of manufacture. When packed, the hoops fit one within the other, causing the globe to occupy but a very small space. Although they cannot be packed in so small a space as those that are not hooped, they are in other respects much the most convenient; and the whalebone hoops may also be bent or doubled crosswise, and they will again resume their shape, see fig. . These, as well as all the globes before described, may be mounted like other globes by the insertion of an axle, or pivot, in the tubes at the poles, one of which, the self-acting valve tube, is designed for inflating the globe, the other for letting off the air.

BLACK AND WHITEBOARD.

SLATE AND MEMORANDUM PAPER.

Experiments have recently been made with the gritted goods for these purposes, which promise to be successful. A particular account of them will be deferred until more is known of their utility.

SLATE AND PEN-WIPER.

This trifling article is made of gum-elastic sponge, and is very complete for the use for which it is designed.

INKSTANDS.

Among the numerous kinds of inkstands, made from a variety of substances, such as cork, wood, earthenware, china, stone, glass, leather, and the metals, those made of vulcanized gum-elastic may fairly claim particular notice, especially for pocket inkstands. They are durable as metal, extremely light, or (when loaded with metal) as heavy as may be desired, and have one peculiar superiority, that of being soft to the pen, and may have the pen-wiper of gum-elastic sponge attached to, and forming a part of the inkstand.

They can be manufactured of any desirable shape, either of caoutchouc whalebone or ivory, combined with elastic com pound and sponge, advantageously.

IMPROVED INKSTAND.

An improved inkstand is made from caoutchouc whalebone, elastic compound, and sponge combined. The ink is raised by compression in different ways. In the one represented in the plate, fig. , the ink is contained in a sack within the inkstand. In that represented by fig. , the sides of the inkstand are formed of elastic compound. In both kinds, turning a screw raises the ink: in fig. , it is done by the follower of the sack; and in fig. , by the top of the inkstand being screwed down.

INKSTAND PACKING.

This is used in a variety of ways, for making inkstands of different kinds tight in the joints. As the public are more or less acquainted with this use of the article, a description of them is considered unnecessary.

ARTISTS' INDIA RUBBER.

It would seem hardly possible to improve upon the properties of the native gum, for erasing pencil marks, all things considered, and yet the vulcanized article has peculiar properties, which are desirable in some cases. It is made of three qualities, the gritted sponge compound, which is very soft and yielding; the gritted magnesia compound, which is very hard, so that it will retain an edge or point, and very nearly answers the purpose of a knife for erasing; and a medium quality which is gritted, and resembles nearest the native gum. All these kinds are sharper, or cut faster than the native gum, but being less adhesive, that which is removed from the paper does not adhere to them, but has to be blown off, on this account they are thus far objectionable.

The durability of these kinds of erasive gum, makes them applicable to the pencil-heads hereafter described, for which the native gum would not answer so well.

PENCIL-HEADS.

These are made of the artist's India rubber before described; they are set into metal sockets, as represented in the plates, figs. 1, 2 and 3, or are formed into rings or heads which are intended to slip over the ends of a wooden pencil or crayon of any description, as represented in figs. 4 and 5. The advantages to be derived from these pencil-heads are these: viz. being attached to the head of the pencil, they are always at hand for instant use, and are convenient either for the pocket or the desk, and though so very small, are so durable as to do the service of pieces of native gum many times larger.

RULES.

Rules of different kinds, both solid and hollow, are made very complete of caoutchouc ivory and whalebone.

PORTFOLIOS.

A superior portfolio is made of caoutchouc board or whalebone combined with gum-elastic vellum instead of morocco. The tablet is sometimes made with an extra thickness of vellum, or a sheet of the gum-elastic sponge fabric overlaying the cover, either of which forms a superior tablet for writing upon.

DESK COVERING.

Gum-elastic felt or vellum is a very cheap and suitable article for the covering of counting-house, portable, and school desks. It is easy to write on a single sheet of paper upon either of these articles.

MAP CARPETS.

Different kinds of map carpets are found useful for the covering of floors, or the aisles of academies. These carpetings are variously described, Chapter , but that which may be particularly recommended for school-houses on account of its cheapness and softness, preventing noise, is the cotton or woolen fibrous article.

PENS.

The application of caoutchouc whalebone to this use was first suggested by another.*

The material has evidently the properties suited to this manufacture ; and from the trial that has been made of these pens, they appear to combine the good qualities both of the steel and quill pen, and on some accounts to be better than either. They are not rusted by the ink like steel, or softened like the quill, and move more smoothly on the paper than either the quill, steel, or gold pen.

PENCILS AND CRAYONS.

The use of vulcanized India rubber for pencils and crayons was first made by another, † by mixing the materials used for them, whether black, red, or white, with the gum. By this invention a great objection to most lead pencils appears to be overcome ; instead of crumbling like the lead, they are somewhat elastic, make a good mark, and may be cut like leather.

* James A. Dorr, Esq., New York.

† Mr. John Rider, New York.

CHAPTER II.

CARPETINGS, TENTS, AND AWNINGS.

Carpetings. Floor-cloths. Mosaic carpeting. Sponge carpet. Crumb-cloths. Tent carpets. Tents. Single tents. Tent fly. Awnings. Roofing.

CARPETINGS.

The utility and economy of this substance for a variety of carpetings, has been proved beyond a question, and no objection whatever has been found to them, except that which may, in some cases, be made to the odor of the gum.

To numbers who have used them, this has not been found an objection, particularly where the goods have had some months' age before they were put to wear.

The plated and fibrous fabrics are specially recommended for the different kinds of carpeting, because the gum does not peel from them, and likewise because these goods are so inelastic that they do not stretch and become loose, or crack, like the ordinary floor-cloths.

Gum-elastic is particularly adapted to resist that kind of friction to which carpeting is exposed. To illustrate this fact it is only necessary to allude to the durability of the soles of the overshoes, and to the report of some experiments that were made to test the wear of vulcanized gum-elastic, as compared with iron, which are stated, page .

FLOOR CLOTHS.

Are made of the plated or fibrous fabrics, either of cotton or wool, and printed with oil like other floor cloths, or with callenders and in lithography, like other India rubber fabrics.

When printed with oil, the pattern does not wear off so soon as from the common floor cloths, because the ground of the carpet is softer, and when printed in lithography is still more durable, because the ink penetrates the gum. It is also softer to the feet, does not crack under any circumstances, and possesses this very great advantage, that, when the pattern is worn off, the goods are hardly less valuable than when new. They can be re-stamped or re-printed, and may be applied to other purposes, such as tarpaulins, &c. When the gum is applied to one side only of the woolen fibre, the other side being printed, a woolen winter carpet, as well as a gum-elastic summer carpet, is obtained from the same article. The same result is obtained where one side of the goods is napped with flocks.

MOSAIC CARPETING.

This is made like the carpeting already described of the same materials, with this difference ; the pattern is worked in or laid on, the colors being mixed with elastic compound cement, and laid on during the process of manufacture, while the goods are in a soft state, by which means the figure becomes part and parcel of the carpet, and like mosaic, durable as the carpet itself. Marbled and simple patterns are formed in this way by stenciling. More elaborate patterns are formed by printing in colors by lithography ; and when these goods are finished by the method described under the head of Indelible Fabrics, (of which mosaic carpeting is considered one of the most important,) as

beautiful patterns landscapes, &c., can be produced, as can be desired; and, at the same time, as durable as the fabric itself.

SPONGE CARPET.

This carpeting is made of the same materials, and is printed in the same styles as the two kinds before described. The peculiarity of this article, which forms its chief recommendation, is, that the back of the carpeting is formed of gum-elastic sponge, which renders it soft and elastic, even more so than the softest and most expensive kinds of woolen carpeting.

CRUMB CLOTHS.

These are but a lighter kind of carpet made of the plated or fibrous fabrics, which are made up at the factories into crumb cloths, from eight to twelve feet square, intended for the protection of other carpeting, and commonly, under the table. This article, which has already been introduced to considerable extent, has given entire satisfaction.

TENT CARPETS.

These are made of the same material as the carpeting before described, except that they are of a lighter sort, and so constructed with eyelet holes, that they may be used upon occasion as tents or awnings. When attached to the tent with snaps, as represented in plate , fig. , they render it warm and comfortable, and prevent the rain and snow from driving underneath the tent. It may be considered superfluous to remark upon the adaptation of these fabrics to this use, or to say that whenever

persons are compelled to sleep on the ground, whether in journeying or in encampment, especially when they are thus exposed to wet weather, or upon marshy soil, an article which excludes all dampness must be a great comfort, and a great security to health.

TENTS.

Are made of plated cloths or corded and barred fabrics, and of various patterns, some of which are represented in plate . An objection has formerly been made against India rubber goods for tents, on account of their closeness, excluding the light, and on account of their being black, they were considered hotter in sunshine than canvas. But with the improvement lately made in lighting and ventilating gum-elastic tents, as represented in plate , fig. , together with the fact that they are now made white and have the appearance of canvas, it is suggested that these fabrics will be found to answer this purpose better than the cotton and linen canvas heretofore used for tents. Among the different patterns represented in the plates that may be noticed, are fig. , made of ventilated goods. Fig. , which is pitched with a pole that is jointed, and may be readily taken in parts for transportation. The utility of India rubber tents has thus far been questioned, partly on account of the first cost, and partly on account of the objections stated. By the introduction of the fibrous fabrics, the first objection will be removed, and it is thought that the latter one will be so by the improved varied construction of the articles.

SINGLE TENTS.

Single tents may be best formed of the plated or corded gum-elastic fabrics. They may also be made by pitching the camp blanket, which is sometimes constructed with eyelets, and a fly for this use, as represented in the plate, fig. ; about one-third of the blanket being turned under, so as to form the carpet or bottom of the tent. It is often very desirable to use gum-elastic for sleeping on the ground, but on account of its closeness, in dry and moderate weather, it is unsafe for one to be wrapped in it closely. The use of caoutchouc for the single tent is without objection.

TENT FLY.

This might be properly termed an awning made with eyelets, which is sometimes used in stormy weather, or hot sunshine, over cloth or canvas tents, in the manner represented in the plate. It may also be used with economy as a chaffing mat, or a tent carpet.

AWNINGS.

Where the first cost of awnings is not a consideration, the cheaper gum-elastic fabrics may be used advantageously, on account of their durability and waterproof quality. Plated linen musquito netting is most suitable among the different fabrics for this purpose.

ROOFING.

One of the most frequent inquiries of those who speculate upon the uses of India rubber is, Why is it not suitable for roofing. A canvas substantial enough for this purpose, coated by the former method, would have been too expensive. By the present method, however, of plating such canvas with caoutchouc and cotton fibre, a roofing may be made to answer exceedingly well, and not too expensive.

CHAPTER III.

COVERINGS AND SPREADS.

Wall coverings. Table spreads. Piano-forte covers. Box covering. Trunk covering. Umbrella cloths. Bellows coverings. Instrument covers. Matress covers. Coffee, grain, and fruit covers. Hay rick covers. Storm hat covers. Jar covers. Phial mouth covers. Baggage covers. Desk coverings. Bed spreads. Bed covering and ticking.

Gum-elastic spreads and covers, of various sorts, have heretofore been made of coated cloths, instead of which the fibrous fabrics are recommended for these purposes. The heavier sorts may be nailed or laid upon wood or pasteboard, with paste or glue, and are decidedly more durable than leather of the same thickness for covering trunks, boxes, &c.

WALL COVERINGS.

Gum-elastic tissue, or very thin vellum, is well adapted for the covering of walls. It may be either printed like paper-hangings, or in lithography, or with calenders after the manner of calico printing.

Its most important use is probably the covering of walls, which are exposed to damp. If these fabrics are applied with gum-elastic, or any water-proof cement, they make a desirable covering for walls in cases where paper is useless. When finished after the various styles of printing, coloring, or gilding, they are as elegant as can be desired.

They will not soil easily, and when soiled can be easily

cleansed by washing. Their great durability recommends their use instead of ordinary paper-hangings, although their first cost is more than the cheaper kinds of paper.

TABLE SPREADS.

Are made of napped and plated fabrics. These goods are proved to be particularly adapted to this use, and are found to be most effectual in preserving furniture from dust, and the effects of the atmosphere. Various kinds of ornamenting are made use of for this purpose, so that the article may be as highly ornamented as can be desired, either by printing, painting, gilding, or bronzing.

PIANO-FORTE COVERS.

Like the table spreads already described, are made of napped and plated fabrics. Their great superiority consists in their preserving the tone of the instrument, by protecting it from the changes of the atmosphere, and the polish by keeping it secure from dust. Previous to the discovery of the vulcanizing process, common India rubber cloths were, for the above reasons, uniformly used for this purpose, by one of the most celebrated piano-forte makers in the United States, to protect the instruments in the warehouse previous to sale. The same remarks apply to these covers that have been made of table spreads and indelible goods, in regard to finish and ornamenting.

BOX COVERING.

Bandboxes, and a great variety of pasteboard and light wooden boxes, may be covered with vellum or tissue to great advantage; tissue being used for the lighter, and vellum for heavier kinds. The goods may be applied to the wood or pasteboard either with paste or glue, in the same way that leather and paper-hangings are applied. That travelers in the present age should rest satisfied with the slight service rendered by paper boxes, can only be accounted for by their cheapness. Although their first cost is but little, they are in the end expensive on account of the very short time they last, oftentimes when exposed to wet, not answering for a single journey. By covering paper boxes with vellum, and staying them in the manner described, page   , specimens of these have been found to do service for years, like trunks.

TRUNK COVERING.

Vellum is suitable and cheap for the covering of trunks, and vegetable leather as a substitute for animal leather for the heavier and more expensive kinds of trunks. The goods may also be used as a substitute for canvas, and made up with the needle for outer coverings, or chaffing mats, for boxes and trunks, where it is desirable to protect them from wet.

UMBRELLA CLOTHS.

Gum-elastic tissue, corded tissue, and plated muslins, are best suited for umbrella coverings. The lightest description of plated cotton musquito net is very suitable for this purpose. All these fabrics may be made up with the needle, but are most completely made up at the factories, as described under the head of Umbrellas, Chapter

BELLOWS COVERINGS.

Among the many uses of these fabrics, there are probably none to which they are more perfectly adapted than for the covering of bellows. The fact of this important use of the fabrics having been hitherto so little noticed, can only be accounted for by its being lost sight of in the multitude of other applications of the fabrics. Gum-elastic vellum is most suitable for small hand and accordion bellows; plated canvas and vegetable leather for smiths' and organ bellows. With these fabrics there is no loss of power, as is the case with animal leather, by the escape of air through the pores. They are not scorched or ignited from sparks like leather, and they are not injured by water. They are, for these purposes, undoubtedly more durable and cheaper than leather.

INSTRUMENT COVERS.

Instruments of various kinds are advantageously covered with the fabrics. Musical instruments are well protected by them

from the changes of the atmosphere, and dust, and it is asserted by the most celebrated instrument makers, that the tone of instruments is preserved by the use of these covers. They are manufactured in the shape of bags or cases, quite air-tight, or otherwise, to fit the various instruments for which they are intended.

MATRESS COVERS.

These are made of impervious plated fabrics, and are intended expressly for camp or ships' use, for the protection of beds and matresses. The mouth of the cover may be tied tight enough to exclude water when immersed in it. A number of matresses protected by these covers, when thrown into, and secured to a boat ever so leaky, will make it a complete life-boat, much safer to rely upon than if the same matresses were filled with air. The same covers will, upon occasion, serve as ships' letter-bags, or for the preservation of property, and when filled with light articles will answer the same purpose as above specified as floats or life-preservers.

COFFEE, GRAIN AND FRUIT COVERS.

These are made of plated caoutchouc fabrics, of a conical form, at the factories, and are well suited for the protection of coffee, grain, or fruits, but more particularly coffee, when gathered and left for a time in the fields. See plate , fig. .

HAY RICK COVERS.

These are made at the factories, of the same material, in the same way as coffee covers, already described. For such a use,

the first cost of a sufficient number of these to protect the hay of a whole field is an objection, but when it is considered that the same set may be used by a neighborhood, and when the length of time they will last is taken into consideration, they will be found to be economical.

STORM HAT COVERS.

These are made of tissue or corded tissue, either at the factories or with the needle. They are designed as a substitute for the oiled silk covers, being not only better, but much cheaper than the oil silk. They are sometimes made with a cape of tissue, see plate , fig. . This article, when made with the cape, like the storm cap or cape, will be found very useful and exceedingly comfortable to the wearer in stormy weather.

JAR COVERS.

The tops of these are made of caoutchouc whalebone or board, covered with tissue or vellum, united with a rim of gum-elastic compound, see plate , fig. . They will be found to answer a good purpose for housekeepers for securing pickle, preserve, and other jars, and for making them perfectly tight, which it is often exceedingly difficult to do, either by common corks or by tying.

PHIAL MOUTH COVERS.

Gum-elastic drapery and tissue may often be used with advantage by druggists and others, for securing the mouths of bottles, jars, and phials, instead of skins and parchment, that are often used.

BAGGAGE COVERS.

Baggage covers are manufactured of plated, corded, and barred caoutchouc fabrics. These fabrics are lighter, stronger, and much more suitable for this purpose, than the India rubber coated cloths that have been heretofore applied to this use. It may be said that this is emphatically one of the proper and unobjectionable uses of gum-elastic fabrics.

DESK COVERING.

See Chapter I.,—Educational.

BED SPREADS.

Plated cloth and vellum are both found useful for this purpose. They are made from a yard to a yard and a half square, and are commonly cut from the fabrics that are sold at the shops, for the protection of feather beds and matresses in cases of sickness, and in the nursery. When spread upon the bed and under the clothing, their use is without objection. This article is not designed as an outer covering or spread, and should not be used for that purpose, except when persons are exposed to storms or extreme cold.

BED COVERING AND TICKING.

The *porous*, fibrous, and plated fabrics will be found suitable on ship-board and elsewhere, for the above uses, on account of their cleanliness and durability.

CHAPTER IV.

HOUSE, SHIP, AND CAMP WARE AND UTENSILS.

Clothes brushes. Portable brushes. Scrubs. Hand scrubs. Covered bottles and phials. Covered demijohns. Wash-boards. Sieves. Screens. Tunnels. Bellows. Ice-water tanks. Wood carriers. Muff bags. Muff boxes. Door mats. Table mats. Coffee-pot and urn strainers. Pans and dishes. Tea and coffee sets. Improved preserve jars. Flower-pots and vases. Flower sacks. Ewer and wash bowls. Pitchers and tumblers. Water buckets. Portable water buckets. Fire buckets. Portable fire buckets. Wash tubs. Portable wash tubs. Baskets. Portable baskets. Dish baskets. Market and fish baskets. Coal hods. Table cutlery. Pocket cutlery. Furniture. Improved brushes. Elastic brushes. Paste bag.

These articles are made of the different fabrics and wares; when required, they are stayed in various ways with iron or wood, in order to render them more or less portable, or give them a greater or less degree of stiffness. It may be stated in respect to a great variety, if not all articles of this kind which are not to be brought in contact with fire, that in many cases they possess peculiar advantages over either earthen, wood, or metal, especially for ships' and camp use; and, although for some time to come their first cost must be greater than that of wood or earthen, yet, when properly made, they will be found, in consequence of their durability, in comparison with other things, *not to be expensive.* Descriptions and drawings of only a few of these articles are here given. The recent introduction of sponge and the hard compounds among the fabrics, bids fair to extend this chapter almost indefinitely, if there is ever an attempt to enumerate all the articles of this kind that may be made of them to advantage.

CLOTHES BRUSHES.

These are constructed of elastic sponge, of various forms and patterns, either fastened upon a wooden or caoutchouc ivory

handle, or so shaped and otherwise stiffened as to need no handle. They do not remove dust from some cloths so well as bristle brushes, but in every respect they may be said to answer the general purposes of a brush far better than bristles; and they are decidedly more effective than any other brush for cleaning silk and cotton velvets, also silks and crapes. If any persons are disposed to question the utility of these brushes, let them consider the peculiar property of gum-elastic, and its usefulness in cleaning paper, and they will not doubt that it may also be adapted to the purposes here specified.

PORTABLE BRUSHES.

These are also made of coarsely embossed elastic compound, or vellum, or gum-elastic sponge, so constructed as to be inflated with the self-acting valve tube like other air-work, as represented in plate xiii., fig. 1. The same properties attach to them as to the brushes before described, with one other advantage, they can be packed in a very small compass when collapsed.

SCRUBS.

Scrubs are made of caoutchouc sponge or packing fastened upon blocks of different kinds, with or without handles, according to the use for which they are designed. They are fast getting into favor for scouring vessel's decks, and for the scrubbing of floors. They are incomparably more durable and economical than bristles. A nautical term, that of squeal-gee, is also applied to this article with a handle. See plate xvi., fig. 1.

HAND SCRUBS.

These are made of a heavy sheet of gum-elastic sponge, fastened upon a board, to be used for the purpose of scouring floors. For this purpose they are more effectual than brushes made of bristles; and on account of their durability, are in the end, much cheaper. See plate xiii., fig. 2.

COVERED BOTTLES AND PHIALS.

These are first covered with gum-elastic vellum, and afterwards with caoutchouc whalebone. They are subsequently vulcanized in moulds. Coverings of this sort serve to keep the bottles or phials from breaking, and they possess one great advantage over those heretofore covered with willow, straw, and splints, that when the bottles are broken, the contents will be safe; such covered bottles being in fact two bottles, one internal of glass, and one external of gum-elastic.

For persons travelling, for ship's use, and for sportsmen, their superiority cannot fail to be appreciated. Small bottles and phials are most neatly made by being first covered, and then heated in moulds like hollow ware, by which method greater uniformity, and more perfect execution can be attained in the workmanship.

COVERED DEMIJOHNS.

These are covered in the same way as phials and bottles, except that a heavy description of gum-elastic vellum cord is used for covering them, and the glass is protected by a heavier coating of vellum; or, for many purposes glass need not be used, but the demijohns may be made like sportsmen's bottles, or

flasks of caoutchouc whalebone, and stiffened with hoops and bands of wood or iron. Demijohns of this sort may be highly recommended for containing acids, which soon destroy willow coverings; and also for wines and liquors, which improve by being kept from the light. One important consideration in the use of these demijohns is, that there is no danger of the loss of the contents, even if the glass breaks, or of other goods being damaged from the spilling of acids, which often happens from the breaking of demijohns. See plate , fig. .

WASH-BOARDS.

These boards are made with a covering of elastic sponge, moulded in the common form of wash-boards. Few specimens of the articles have yet been made, but from the trial that has been made of them they may be expected to give satisfaction, although the first cost may prove a hindrance to their general use. The elastic sponge will probably also be found useful in its application, among the numerous varieties of washing machines that are now made wholly of wood.

SIEVES.

The hoops of this article may be manufactured of caoutchouc board, whalebone or other suitable materials. For the sieve or strainer, perforated elastic compound or whalebone is used. How far this article will be adopted for common use, remains to be seen; but the inventor is of opinion, that in certain cases, they will be found highly useful for straining or cleansing articles or chemicals that corrode, and destroy haircloth or wire sieve.

SCREENS.

These are made of perforated caoutchouc drapery, or whalebone, which may, in many cases, be substituted in safes, windows, and cupboards for metal gauzes, on account of its cheapness, and not being liable to corrode.

TUNNELS.

Are made of cord ware, hollow ware, elastic compound, or caoutchouc whalebone. They are designed for druggists' use, as a substitute for glass or wedgewood. For common use, they possess the superiority over tin of not being liable to be damaged, or to corrosion. When made of cord ware, hollow ware, or elastic compound, they have another advantage, that of being portable. See plate xiii., fig. 3.

BELLOWS.

Wooden bellows are covered with the vulcanized fabrics, as proposed under the head of bellows' covering. An improved kind of smith and other bellows is made by covering a hoop of iron or wood, as represented in plate xiii., fig. 4, and afterwards cementing the covering to the hoop. This kind is made up only at the factories, while the gum is in a soft state. Beside the advantages which have been claimed for these fabrics, under the head of Bellows Covering, this article avoids entirely the great objection of leakage, about the parts where leather is commonly nailed to the wood, of which almost every person must have knowledge who has had much occasion to use bellows.

ICE-WATER TANKS.

This article is made of vegetable leather, and is constructed with two apartments, one for ice, the other for water, with a faucet attached, as represented in plate , fig. . It answers the purpose of keeping water cool a great length of time, when ice is put into the separate apartment, and equally as well with bad as with good ice.

WOOD CARRIERS.

Though an article of limited demand, may be advantageously made of vegetable leather or plated canvas, instead of harness leather, which has heretofore been used for this purpose. See plate xiii., fig. 5.

MUFF BAGS.

These are made of plated or *corded vellum,* with a mouth of light fabric, of gum-elastic vellum or tissue, that may be tied quite tight. They are a cheap and valuable article for the protection of furs and woolen goods from moths. If the articles are well shaken and beaten before they are packed, for the purpose of removing the eggs of the moth, the goods kept in these bags will be safe from the ravages of this destructive insect.

MUFF BOXES.

These are made of pasteboard, covered with gum-elastic tissue or vellum. The lids are made so as to be air-tight, when shut, in the same manner as bandboxes, see plate , fig. . Furs that are well beaten and shaken before they are packed, will not be molested by moths if kept in these boxes.

DOOR MATS.

These are made of covered cordage or elastic sponge, of the same pattern as the common rope-mats, or otherwise. The superiority claimed for this article, consists in its softness and durability, and the ease with which it may be cleansed, simply by rinsing it in water ; besides, they are not liable to decay, or to get damaged, by being left outside the door, exposed to the weather. See plate xiii., fig. 6.

TABLE MATS.

These are made of gum-elastic wicker work, or heavy vellum, or caoutchouc whalebone, all of which fabrics are well adapted for the article. The fabrics may be elegantly ornamented after the manner of indelible goods, as well as in various other styles. They are in no way affected by the heat of dishes, and are recommended on account of their great durability and cleanliness.

COFFEE-POT AND URN STRAINERS.

These are made of perforated caoutchouc ivory. It is supposed that this fabric will prove superior to tin or metal for this and other like purposes, because it will not rust like tin, nor corrode like metal.

PANS AND DISHES.

Some kinds, at least, of pans and dishes may be made with advantage from gum-elastic, both from the elastic fabrics and from caoutchouc enamel, which are superior for some uses to such articles made of other materials. This was proved at an early day by the use of the article in the factories in the course of the inventor's experiments. They were made from curiosity, or from the want of them for immediate use. The lapse of time, however, proved that they remained whole while successive sets of tin and crockery were either rusted out or broken. This circumstance first suggested the idea of making them for the market.

TEA AND COFFEE SETS.

These sets are manufactuted to be used in the field, the camp or kitchen, and on shipboard. In many cases, there will be economy in their use; though to recommend them generally instead of crockery, would be absurd.

IMPROVED PRESERVE JARS.

Different methods have been suggested in this work for corking and covering preserve, pickle, and other jars; another method, invented by a crockery merchant of New York, although somewhat more expensive, may be considered an improvement deserving particular notice. The covers of earthen or china jars, (the jars being suitably constructed for this purpose,) are, by a screw and bar, or cross-piece, pressed down upon a shoulder or rest in the jar, which is made quite airtight by means of a ring or packing of gum-elastic between the lid and shoulder of the jar. See plate , fig. .

FLOWER-POTS AND VASES.

Perforated caoutchouc whalebone or board, although expensive in comparison with crockery or wood, is a suitable material for flower-pots, on account of the free transmission of air and moisture through it. Caoutchouc ivory, not perforated, may be applied to flower-vases without the same objection of expensiveness, for the reason that it may be made so ornamental as to be substituted for china, and because they are not liable to be broken like china, while they are equally water-proof.

FLOWER-SACKS.

This is a convenient and useful little article for the florist, or others who wish to transport or carry flowers with moisture, or roots with earth. They are made by machinery from gum-elastic fabrics, after the method described, Vol. I., page , and with such rapidity and cheapness that they may be afforded at the reasonable rate which is required for a purpose like this.

EWERS AND WASH-BOWLS.

The liability of these articles to be broken, when made of earthen, particularly where they are used on board ship, in hotels, and in all situations where water may be left to freeze in the ewers, renders the application of gum-elastic to their manufacture very desirable; they may be made either of caoutchouc whalebone or ivory.

PITCHERS AND TUMBLERS.

Sportsmen's cups of different kinds, and portable or flexible pitchers of gum-elastic compound, have been described elsewhere in this work, but the articles here referred to, which it is supposed may be found useful, are made of caoutchouc whalebone. They are not liable to be broken, and there does not appear to be any particular objection in their use.

WATER-BUCKETS.

Are manufactured of caoutchouc whalebone or board, with a hoop of wood or iron around the top covered with the same material. These buckets are not only useful in many cases for vessels, for the camp, and the garden, but also for the kitchen.

PORTABLE WATER-BUCKETS

Are made of gum-elastic felt or vegetable leather, stayed around the top with a covered hoop of wood or iron, in the same way

as the buckets before described. The fabrics are made of that degree of flexibility that the bucket may be compressed into a small space for transportation, and yet so firm and elastic that it will resume its shape when unpacked. For this, among other reasons, it is a useful bucket, particularly for coachmen and wagoners. See plate , fig. .

FIRE-BUCKETS.

Caoutchouc whalebone and leather are suitable materials for fire-buckets, from which they have been made, to considerable extent, in the United States.

In the early stage of the manufacture, coated canvas was used for water and fire buckets, which did not give satisfaction on account of the gum peeling from the canvas, but since the above articles have been substituted for the canvas, a good article has been obtained. See plate , fig. .

PORTABLE FIRE-BUCKETS.

It is oftentimes necessary, and especially on board of vessels, to carry a number of water or fire-buckets, to which there is a great objection on account of the space which they occupy. A kind of bucket which it is proposed to manufacture of caoutchouc leather, is represented in plate , fig. . The shape of this article appears to be objectionable, as it does not open so as to be round like other buckets, but it is supposed that the advantage arising from the compactness of stowing them, may more than counterbalance the objections to their shape. When in use they are kept open by a brace at the top. See plate , figs. .

WASH-TUBS.

These are manufactured of caoutchouc whalebone or board, and stayed with wood or iron hoops and splints, covered with gum-elastic materials. They may be recommended for lightness and durability, for ship and camp use, if not for the kitchen. See plate , fig. .

PORTABLE WASH-TUBS.

Portable wash-tubs are manufactured of caoutchouc plated and corded fabrics. They may be attached to a wooden frame or horse, as represented by the child's bath-tub, plate , fig. or they may be arranged by movable supports, as represented by the bath-tub, plate , fig .

BASKETS.

Field and other baskets may be manufactured of wicker-work. Although more expensive, they are more durable than splints or willow. Fancy and fruit baskets are also made of caoutchouc, without objection on the score of expense, in comparison with many other kinds that are less durable.

PORTABLE BASKETS.

Baskets of different sorts are so constructed of gum-elastic wicker-work, as to have that degree of pliability that they may be compressed in a very small space, and afterwards resume their shape with stiffness sufficient to be used for all ordinary purposes.

DISH-BASKETS.

Baskets of any kind, such as are used in public houses or on board steamboats, when lined with gum-elastic vellum, instead of zinc or tin, will be found lighter to carry, occasioning less noise, and less risk to the dishes placed in them, than when lined with metal.

MARKET AND FISH-BASKETS.

These baskets, which have usually been made of willow or splints, may be advantageously made of caoutchouc whalebone and vegetable leather, and are very valuable on account of their durability, water-proof quality, and cleanliness, for purposes of this sort, for the reason that they may be used for marketing, and afterwards cleansed, so as to be used for liquids, or other substances, such as flour, meal, &c., if desired.

COAL-HODS.

Coal-hods are manufactured from caoutchouc whalebone board or vegetable leather; they are stayed and rendered firm by hoops and braces of wood or iron.

The improvement which may fairly be claimed for this article is, that it will not rust like sheet iron, that it is cheaper than copper or brass, and is not noisy to use like either of these.

TABLE CUTLERY.

One of the most important applications of caoutchouc ivory is that of handles for table cutlery. When put on in a soft state,

before they are vulcanized, they adhere so firmly that they will not come off, and it is impossible to get them off without great violence; neither are they in any way injured by lying in boiling water any length of time; are equally beautiful as buffalo-horn or ivory, and may be ornamented and inlaid in a variety of ways.

POCKET CUTLERY.

A very important improvement is made by the use of caoutchouc ivory for the scales or covering of the handles of pocket cutlery, as well as the handles of many other instruments.

The ivory scales are joined to the handles without rivets, when the ivory is in a soft state, before being vulcanized. This method is more particularly described in the inventor's specification of the patent for this improvement.

FURNITURE.

Different kinds of furniture may be covered with veneers of caoutchouc enamel rolled out into thin sheets before it is vulcanized. The cost of these veneers, in comparison with fine wood of different kinds, is much less, and they are unquestionably superior on the score of hardness and durability, from not being liable to warp and crack.

IMPROVED BRUSHES.

Several kinds of brushes, and particularly clothes, hair, and tooth brushes, are made advantageously of gum-elastic ivory and whalebone, in the following manner. The block or part in which the bristles are inserted may be made of wood or of gum-elastic whalebone. In this case, the holes in which the bristles are inserted are made with pins by one impression or stamping in the plastic material. The part in which the bristles are inserted is afterwards glued or fastened by screws into the handle of India rubber ivory, which is made with a rim around the edge to receive it. See plate , fig.

ELASTIC BRUSHES.

These brushes, which are of curious construction, are formed of octagonal or round tubes of elastic compound, set endwise upon a handle of caoutchouc ivory. These tubes are cemented together at the sides, and when cemented upon the handle, the brush has the appearance of a honey-comb on the face. They are better than the sponge brush, described in the beginning of the chapter, for removing dust from garments, but not so good for removing grease spots, &c. See plate , fig.

PASTE BAG.

The inconvenience of keeping flour paste for any length of time in such a state that it will not soon dry up, is experienced by many. This difficulty may be avoided by the use of a bag made of India rubber fabrics, as represented plate , fig. That represented by fig. , made in the shape of a plain bottle, fig. , is constructed like self-inflating air-work. In both of them the tubular stopper is used. This bag will be found both economical and convenient.

CHAPTER V.

MECHANICAL.

Machine belting. Well ropes. Deckel straps. Elevators. Cane elevators. Printing tympans. Printers' rolls. Compressing apparatus. Preserving apparatus. Improved portable preserving apparatus. Steelyards and scales. Bakers' belting. Printing aprons. Match dies. Windmill sails. Thimbles. Sail-makers' thimbles. Stereotype plates. Stereotype moulds. Tool handles.

The appliance of the fabrics, and particularly of the elastic compound, to machinery, and also its uses in facilitating in various ways the manipulation of different departments of numerous manufactures, continue to increase; descriptions of such of them as are ascertained to be certainly useful, are given in this chapter.

MACHINE BELTING.

This was one of the first manufactures of India rubber in the United States. It was manufactured to a considerable extent by the Roxbury Company, as early as 1836. The gum being used upon the inside only, as a cement for holding the different layers of canvas together. It was found to answer tolerably, so that the manufacture of it was continued during the existence of the Roxbury Company. Upon the application of vulcanized gum-elastic to the same use in 1843, the right for that branch was disposed of by the writer to Henry Edwards, Esq., of Boston, who, in 1845, purchased also of him the celebrated Roxbury machinery, and employed it in the manufacture of machine belting. In the manufacture of this article, the gum is used for

cementing several layers of strong canvas together, according to the size of the belt. The gum is also applied upon the outside of the belt. The article is becoming so generally known and extensively used, that to speak of its qualities is unnecessary, except to say that in addition to its general usefulness, it may be considered an indispensable article where belting has to be run under water.

WELL ROPES.

Ropes, or India rubber covered cordage, or straps of narrow machine belting, are advantageously used for wells, on account of their water-proof qualities.

DECKEL STRAP.

The deckel strap is a belt of vulcanized gum-elastic, about one inch in thickness, and one inch and one-fourth in width, and from ten to twenty feet in length. This article is used as a part of the fondernier machine for the manufacture of paper, and prevents the pulp from escaping in the revolution of the machine. This is one of those peculiar applications, in which both the elastic and water-proof qualities of this substance are desirable, and in which no other substance answers so good a purpose, as it is run constantly in water.

ELEVATORS.

These are made of caoutchouc fabrics, the belt of the elevator being made in the same way as machine belting. The buckets may be made of tin, and attached in the same way as has com-

monly been done with leather elevators, or they may be made of caoutchouc whalebone, and cemented on in the process of manufacture. They are used in flour mills for elevating flour and grain, or other articles, from vessels to store-houses, see plate , fig. . The cheapness of this article, as well as its durability, recommends it to the notice of millers in particular.

CANE ELEVATORS.

It has been suggested by a gentleman formerly engaged in the manufacture of sugar in Louisiana, that broad India rubber belts, with carriers attached, would be made very superior to the elevators now in use for elevating cane to the grinding mills, when they are placed in the upper story of the building.

PRINTING TYMPANS.

During the whole course of the writer's experiments, frequent inquiries have been made of him by different printers and publishers, at different times, whether India rubber fabrics might not be successfully applied for printing tympans. Various experiments were made at an early day, both with the common and the vulcanized coated cloths. These experiments failed. Recently a trial has been made of the fibrous cotton fabric, or vegetable leather, which appears to be completely successful; and which, if so, is an acquisition to the art of printing.

PRINTER'S ROLLS.

As of printing tympans, so of printer's inking rolls, it is a desideratum with the trade to find some substitute for the common roll, made of molasses and glue. Experiments were made with the native gum, and also with vulcanized elastic compound, both of which failed from being too unyielding. Some experiments are now being made with gum-elastic sponge, which it is confidently expected will prove successful.

COMPRESSING APPARATUS.

This is the invention of another, for the purpose of salting meats. It consists of two copper or iron cylinders, one inserted within the other, and connected by a belt of gum-elastic, as represented by the diagram , plate .

The machine is designed for salting meats instantaneously, or at least in a very few minutes. It has been tried experimentally, and found to answer most completely. The same principle may also be applied to tanning hides, and to other purposes equally well. It is a fact not generally known, that in some climates where cattle are most numerous, as in some parts both of North and South America, the beef cannot be salted at all. Should these machines be found to answer the purpose of salting in these countries, as they do here, it is an exceedingly important improvement, both as relates to those countries and the world at large. Some individuals of enterprise in New York, are, at this time, giving their attention to this subject. Should this application prove successful, a more minute account of the apparatus, and the benefits resulting from its use, will be given.

PRESERVING APPARATUS.

The invention of another, here described, is an apparatus for preserving fruits, vegetables, and other perishable articles from decay, by which they may be transmitted from one country to another. It consists of a box or barrel of any shape desired, with a loose or movable lid; the vessel may be ever so rough or unfinished, but must be strong to prevent collapsing. It is covered with a case of gum-elastic leather in two parts, and a band or belt of gum-elastic compound is drawn over the opening or seam, between the two parts of the covering. When this article with its contents are packed, the air is pumped out, and the tube being stopped, the article becomes air-tight. This apparatus has been tried experimentally for shipments to the West Indies, and found to answer.

The preserving of articles by hermetical sealing has, for many years, been practised to some extent, with tin cases, but the expense of preserving fruits, &c., by this method, would be too great for transportation. It may be expected that by some such method as here proposed, the fruits of different climes may be transmitted from one part of the globe to the other, including such as, from their perishable nature, could not otherwise be kept long enough for this purpose. See plate , fig.

IMPROVED PORTABLE PRESERVING APPARATUS.

The principal, if not the only objection which appears to exist to the invention before described, is the difficulty attending the re-shipment of packages. This has, however, led to an improvement upon this invention, which removes this objection.

When this apparatus is made for transporting articles that are not liable to be injured by pressure, the gum-elastic case is simply a bag of caoutchouc fabrics, in two halves, the edges of which are made of an elastic fabric. These bags are drawn over and secured upon an iron or other metal band, as represented, plate , fig. .

When fruit or other articles which are liable to injury by pressure, are to be preserved, and shipped or transported, these bags are distended by a jointed metal or wooden frame, as represented, plate , fig. .. By this arrangement there is no loss of packages, as in the case of preserving articles in tin boxes. In all cases the air is exhausted from these bags and receivers with the force-pump, through a hose which is attached for this purpose. The frame packed with the bags occupies little space.

STEELYARDS AND SCALES.

The application of vulcanized gum-elastic to steelyards and scales, particularly hay scales, is the invention of another. The manufacture has not been established, but from the well-known properties of this substance, there is little reason to doubt that there will be economy and advantage derived from this application to large scales.

BAKERS' BELTING.

At a very early period, and soon after the discovery of the vulcanizing process, gum-elastic was successfully applied to the

manufacture of belts, upon which the dough is cut by the machines which are used for the manufacture of biscuits and crackers. See plate , fig. .

This was invented by another, and tried with the native gum, previous to the discovery of the vulcanizing process.

PRINTING APRONS.

This is an endless belt or apron, made of gum-elastic felt or vegetable leather; they are used in printing calicos and other stuffs, instead of the woolen felt blankets, which have formerly been used, and are objectionable on account of their expensiveness and want of durability. It is obvious that the properties and texture of this fabric are such as to remedy this defect, in this extensive department of industry.

MATCH DIES.

Gum-elastic compound has been found exceedingly useful for match dies, instead of lead and copper, for striking up impressions in paper, sheet metal, and other materials.

WINDMILL SAILS.

The advantages that may be derived from the use of India rubber fabrics instead of common canvas for windmill sails, are very obvious. They are made from plated canvas and the corded fibrous fabrics.

THIMBLES.

Thimbles may be made either of perforated caoutchouc whalebone or ivory, with metal ends. It is supposed, that for cheap thimbles, these substances will be less objectionable than brass or iron.

SAIL-MAKERS' THIMBLES.

The hand pieces of these thimbles are made of perforated vegetable leather, into which the thimble irons are set before the thimbles are vulcanized.

STEREOTYPE PLATES.

At the suggestion of another, the writer has made these plates from vulcanized caoutchouc whalebone and ivory, and also from the elastic compound, both of which materials it is confidently expected will be found useful in this art.

The practical advantages which are to result from this invention for printing books are yet to be determined; but in other branches of this art, there is no question as to its importance, as in the case of block and cylinder printing for paper-hangings, having the advantage of cheapness, and not being liable to warp or split. The plates may be wound upon drums or cylinders for cylinder printing, without difficulty.

STEREOTYPE MOULDS.

Stereotype moulds, made from the hard compounds of caoutchouc ivory and whalebone, and vulcanized, are unquestionably an improvement which will afford new facilities for moulding other materials, and for multiplying works of art, especially where they are reproduced in caoutchouc compounds. Notwithstanding their first cost is something more than that of plaster moulds or casts, there is great economy and advantage in their use, because, instead of being lost, like plaster, with every impression, they may be used, like metal, an indefinite number of times.

In the state in which the caoutchouc material is used for making the moulds, it is so soft and plastic, that perfect copies may be immediately taken from the finest work of art, in any material, whether metal, plaster, wood, leather, cloth, or paper.

TOOL HANDLES.

It is well known that much perplexity and annoyance are experienced in the use of very many kinds of tools and instruments, from the handles coming loose from them. This evil may be remedied, particularly in all small tools and instruments, by the use of caoutchouc ivory and whalebone for the handles. These handles, when in a soft state, are put on the rough shanks of the instruments, and are vulcanized on them so firmly that they will bear a hard blow of the hammer without injury and without becoming loose.

CHAPTER VI.

PACKING, SHEATHING, AND CAULKING.

Sheathing. Caulking. Engine packing. Box packing. Door packing. Window packing.

The reader will notice that the statements relating to the articles described in this chapter are mostly qualified, except that of engine packing, which has proved quite successful, and the tests in the use of it being so much more severe than upon other articles described in this chapter; the writer feels warranted in assuming something in anticipation as relates to them, notwithstanding they have not yet been sufficiently tested in a practical way. When that shall be, it is believed that the advantages will be found to exceed, rather than fall short of what is here presumed upon.

SHEATHING.

It has at different periods been suggested to the writer, that India rubber fabrics would be useful for sheathing, instead of copper sheaths. The writer's knowledge of the subject, does not enable him to judge in the case. It appears certain that the stayed elastic compound, made as spring hinges are, might be nailed over the seams of the timbers of vessels, so as to stop leakage, oftentimes when they are started; and it is highly probable that the caoutchouc board and whalebone recently invented will answer for sheathing, even if the other fabrics do not.

CAULKING.

This is among the uses that have been suggested for the vulcanized fibrous fabrics. The properties of the substance would seem exactly to adapt it to such a use, but whether it will answer, or if it should answer, whether it will not be too expensive, remains to be proved.

ENGINE PACKING.

This article is made of gum-elastic felt, and is manufactured extensively.

Engine packing of heated or vulcanized gum-elastic felt, is now becoming so well known, and so generally introduced, both in the United States and England, that to treat of its utility would be superfluous.

BOX PACKING.

Dry goods or other boxes for the transportation of merchandise, may be packed and rendered tight by a cord of gum-elastic sponge, drawn into the edges of the article to be made tight, as specified of water-proof boxes and trunks, page , and of improved sash, page .

DOOR PACKING.

The impossibility of making doors and windows at all times quite air and water tight, arises from the swelling and shrinking of the wood, by the alternate changes of the atmosphere, and attempts to make them quite tight often causes a worse difficulty, that of preventing their opening and shutting. It is believed that the plan here proposed will completely overcome these obstacles, as relates to doors. Doors may be made one-half to three-quarters of an inch smaller than the door casing, and a round cord of gum-elastic sponge being inserted in a groove in the door casing, and also in the edge of the door; the two cords together projecting somewhat more than the space between the door and the casing, will make the door tight, and allow it to open and shut, notwithstanding the variations of the weather.

WINDOW PACKING.

Window frames may be packed by grooving the frame, and fitting into the groove a cord of gum-elastic sponge. If fitted into the bottom of the sash also, this arrangement will not only make windows tight, and keep out driving storms, but also guard persons against injury by the falling of windows. For further explanation of this use of gum-elastic for this purpose, see Improved Window Fixtures, Chapter .

CHAPTER VII.

VALVES AND STOPS.

Self-acting valve tube. Pump valves. Chain pump valves. Faucet stops. Engine and bellows valves. Bag clasp. Bag vise stop. Bag slide fastening. Corks. Phial and bottle corks. Expansive cork. Soda fount corks. Jar corks. Demijohn corks. Inflating corks. Improved screw stopper. Improved valve stopper.

THE unalterable properties of heated or vulcanized gum-elastic, as relates to heat and cold, and the numerous grades of texture and solidity of the substances, between that of the softest sponge and the hard vulcanized compound, would seem to render it certain that some of them are admirably adapted for such articles, and in particular those that are used under water, or in liquids.

The first use the writer ever made of gum-elastic, was of the common article, for an improvement in faucets, in 1832. At that time the goods did not answer the purpose. It remained for a professional gentleman* to make a completely successful application of vulcanized gum-elastic to this use.

Some of the articles under this head have been fully tested, and found to be useful; others are under experiment, or being tested, with every prospect of success.

* Doct. Charles Stearn, Springfield, Mass.

SELF-ACTING VALVE TUBE.*

Although this may appear to be a very trivial article, it is very important to the perfection of air-work, and globes in particular. The impracticability of joining gum-elastic to metal, so that it will be secure, is well known, and by the use of metal tubes great injury has been done to the credit of this kind of work, the articles having generally leaked where they are connected with the tubes. This defect is completely obviated in the gum-elastic tubes, inasmuch as they become part and parcel of the air-work to which it is united. The head or part of the tube that projects from the life-preserver, cushion, or other article to which it is attached, is made of caoutchouc whalebone. The lip valve, or end of the tube that is inserted within the article, is made of gum-elastic compound or drapery, or other light gum-elastic material. This lip becomes tight by the internal atmospheric pressure, and when the article is inflated, the greater the pressure the tighter it becomes.

The weight, as well as the expense of the metal tubes, is another objection to their use for all small articles, and particularly for such as globes, fancy, parlor, and bat balls.

In the use of the gum-elastic tube, it becomes necessary to open the valve by means of some instrument; it may be done with a pin, broom splint, or tooth pick, but the most convenient article for this purpose is a small light tube of vulcanized gum-elastic compound, or stiffened paper, which may be looped to the article in the manner represented in the plate , fig. . The writer has adopted another method in some cases, which is more expeditious for letting the air escape, by inserting another tube without any valve on the opposite side of the ball, with a gum-elastic cork attached for stopping.

* The idea of a tube of this sort was first suggested to the writer in 1838 by Mr. E. M. Chaffee, but was only made practicable by the use of the improved fabrics.

PUMP VALVES.

The water-proof quality of the caoutchouc compounds and sponge renders them suitable materials for the above purpose. An application has been made of a valve similar to the self-acting valve-tube before described, and patented by another.* This valve is intended for ships' pumps, and is said not to be liable to be choked, like other valves. It is made of gum-elastic compound, see plate , fig. .

CHAIN PUMP VALVES.

A very simple and useful chain pump, represented by fig. , plate , is being extensively introduced in the United States. It is suggested by the writer, that gum-elastic sponge stops upon covered cordage, would be far cheaper and better for this purpose than the iron chain, and iron valves or stops that are now used.

FAUCET STOPS.

There are numerous ways of applying the caoutchouc fabrics for the improvement of faucets. Among these inventions may be noticed the one first made,† represented by fig. , plate . In this the stop of elastic compound is ingeniously applied in the form of a cone. Another,‡ as represented by fig. , where the fluid passes through an elastic hose, and is stopped either by a

* Dr. E. Pratt, New York.
† Invented by Dr. Charles Stearns, Springfield, Mass.
‡ Invented by

screw or spring lever. Another tap and faucet of the common pattern, fig. , instead of being made of wood, is made of caoutchouc whalebone, the tap being packed with elastic compound.

ENGINE AND BELLOWS VALVES.

Several of the fabrics are, on account of their air-tight and pliable properties, suitable materials for the valves of steam and other engines, and also for the valves of house, organ, and smith's bellows.

BAG CLASP.

This article, as represented by fig. , plate , is made either of *malleable* or wrought iron, in the form of bag clasps heretofore in common use. They are plated with caoutchouc whalebone, with a cushion of elastic compound or sponge fabric on the inside. When shut, the jaws are compressed and secured by hinge catches, which, in connection with the cushion, causes the bag to be quite water- and air-tight.

BAG VISE STOP.

This stop is made of two straight pieces of wrought or malleable iron mouldings, fluted or grooved in a dove-tailed fashion, so as to hold the cushions of gum-elastic sponge with which they are fitted. They are cemented to the bag in such a way as to allow it to open freely, as represented in the plate , fig. . When shut, the jaws are fastened by hinge catches, in the same manner as the clasp above described, which also renders the bag completely water and air-tight.

BAG SLIDE FASTENING.

This slide or fastening for bags is a caoutchouc whalebone tube, made in the form of a tube, with a slit on one side running the length of the tube, as represented plate , fig. . It is slipped endwise over the mouth of the bag, which is made with a cord or projection upon each side of the mouth of the

* The idea of this kind of stop was first suggested by Mr. Nathaniel Hayward.

bag, so as to prevent the slide from coming off, and it is locked on by a padlock at the end.

This stop does not make the bag so completely water and air proof as the two kinds of stops before described, but it is more cheaply manufactured, and renders bags sufficiently tight to answer as life-preservers, when filled with apparel, and it is exceedingly convenient to slip off and on in use.

CORKS.*

As there is something in the manufacture or use of the different sorts peculiar to each, they are separately described as follows :

PHIAL AND BOTTLE CORKS.

The cheaper kinds of these are made plain like common corks. Like other gum-elastic corks, they are made of sponge in moulds, like hollow-ware. They are sometimes made with a rim, as in the plate , fig. , to prevent the cork being driven into the bottle. A somewhat more expensive, but more complete article, is made with a metal eye, and also with a metal plate and eye, as represented in the diagram, fig. 2 and 3. They may not only be drawn by the eye, with a fork or nail, but may be safely connected with the phial or bottle by a gum-elastic cord looped to the eye at one end, and the phial or bottle at the other, see plate , fig. . When it is considered that one of these corks will ordinarily last much longer than the vessel

* The English house of McIntosh & Co. were the first to manufacture India rubber corks, which were made by them of rope or felt, covered with native gum-elastic, as early as the year . These have been used to considerable extent, but they have been found defective for general purposes, from the defects of the native gum.

to which they are attached, corks of this kind may be considered cheap and economical, although their first cost is more than other corks; and certainly so if they preserve the contents of the bottle in cases where they would otherwise be lost by the use of defective corks. In a cheap bottle, these corks may be said to answer all the purposes of an expensive bottle and ground stopper.

The query is here proposed, whether it is more economical in the corking even of cheap liquids, beer, soda, cider, &c., to use in the course of a season one hundred cheap corks for one bottle, or one good cork attached to the bottle one hundred times.

The deterioration of liquors and other articles from defective corks, is a thing of constant occurrence, in particular after the cork has been once drawn by a cork-screw. It is confidently expected that gum-elastic will prove an effective remedy for this evil.

EXPANSIVE CORK.

This cork is made of gum-elastic compound, with a screw of metal or caoutchouc whalebone passing through it. Turning the screw compresses and enlarges the cork, and makes it fast; reversing the screw allows it to be drawn: see plate , fig . This cork is the invention of another.

SODA FOUNT CORKS.

These are made in general like phial corks before described, with the exception of a hole passing them, for the purpose of allowing them to be screwed to the fountain fixtures.

They are found to answer the purpose for which they are intended completely, and their extra cost is of little account, considering their durability and convenience.

JAR CORKS.

The foregoing description may be applied also, in general, to jar corks, except that it may be found economical to manufacture them, and also some of the larger kinds of those already described, by filling the interior of the cork with light wood, refuse cork wood, or other light substances.

Common jar corks being so much larger, are usually more defective, and for them there is the more need of improvement in the article.

DEMIJOHN CORKS.

It has been the practice of manufacturers of acid to use clay stoppers for demijohns of acid, which answer a tolerable purpose until the clay is once loosened, after which the druggist and the consumer have no safe and convenient method of corking up the acid, except by resorting to expensive bottles with ground stoppers. It may be expected that these corks will remedy this deficiency.

INFLATING CORK.

This is a cork made with one of the self-acting valve tubes connected with it, so that the gum-elastic bottles and tanks may be inflated without difficulty, and used as life-preservers; and also that liquids may be drank or drawn from them without taking out the cork or bung. This is done by means of a pipe of vulcanized gum-elastic, or any other suitable material, which may be looped to the cork or bung. It has been found somewhat diffi-

cult to handle flexible gum-elastic bottles or tanks, when the corks or stoppers were out, without spilling the liquids. The design of these corks is to obviate this objection, and also to make them answer as life-preservers for fishermen, sportsmen, and sailors. See plate , fig. .

IMPROVED SCREW STOPPER.

The objections to the use of metal screw stoppers for bottles are chiefly their expensiveness, the difficulty of making them tight, and the danger of losing them. It is proposed to obviate these difficulties in the article here described, made of caoutchouc whalebone, as follows: A swivel, with a ring attached to it, is inserted in the top of the cap of the stopper, by which the cap may be attached to the bottle, or the strap of the bottle.

A washer, of gum-elastic packing, is inserted inside in the top of the cap, which serves to stop the bottle perfectly tight, and, therefore, prevents any escape of the contents of the bottle, either through the screw or through the opening made by the swivel. When attached to India rubber bottles, or to glass bottles covered with India rubber, the female screw of the stopper is cemented into, and forms a part of, the bottle. See plate , fig. .

IMPROVED VALVE STOPPER.

This is the invention of another.* It is formed of two caoutchouc tubes, one within the other; the outer tube is composed of caoutchouc whalebone, the inner tube or hose of elastic compound, which is attached to the outer tube at the bottom only; the ring of the hose being firm at the top serves as a stop. When the flexible tube is straight with the inflexible one, the stopper is free for the escape of air or liquids; but when the flexible tube is twisted, their escape is prevented by the tube being closed, and it is kept so by being held in its place by the ring at the end of the tube. See plate , fig. .

* Nelson Goodyear, brother of the writer.

CHAPTER VIII.

SPRINGS.

Car springs. Carriage and coach springs. Buffers. Cart and truck springs. Wagon seat and rail chair springs. Whale springs. Door springs. Improved door springs. Lock springs. Gun lock springs. Stirrup springs. Umbrella springs. Elastic bands. Elastic ties. Improved hose ties. Girth springs. Hinge springs, or spring hinges. Elastic tape. Glove springs. Shoe springs. Improved shoe springs. Vest springs. Corset and stay springs. Truss and belt springs. Hat and cap springs.

A GREAT variety of springs are made from gum-elastic, many of which it is difficult to make from steel, or any other substance; and if made, it might be impossible to apply them to some purposes to which the gum-elastic spring is applied without difficulty.

Applications of this material for springs are constantly increasing, but the public are so well acquainted with the elastic property of India rubber, that only a brief notice need be given of those springs that are most extensively used.

CAR SPRINGS.

Car springs, consisting of alternate discs of India rubber and metal, like those represented in plate xvii., fig. 1, are the invention of another individual* who many years ago made experiments with the native gum for this purpose, which were unsuccessful. The successful manufacture of car springs of heated or vulcanized gum-elastic, was commenced in America by Mr. Ray soon after that time, and the extent to which it has

* Mr. Fowler M. Ray, New York.

been carried in so short a period is remarkable. As near as can be ascertained, there has been an average of one thousand pounds of gum per day manufactured into this kind of car springs, during the year 1849.

A subsequent improvement has been made in car springs by Mr. Ray, by making the spring of one block of gum, and hooping it with iron rings, instead of using alternate discs of India rubber and metal.

These springs act by the elasticity of the gum by compression. It is applied in the manner represented in plate xvii., fig. 2. To speak of the importance of an article so generally used upon railroads, is needless.

A diagram is given, fig. 3, of a car spring, which, it is thought, may be an improvement in the construction of car springs, on account of the greater lateral motion obtained by it.* Several kinds of air springs have also been invented by different individuals, made of vulcanized gum-elastic, one of which is represented by figs. 4 and 5, plate xvii.;† another, which is represented by figs. 6 and 7.‡

CARRIAGE AND COACH SPRINGS.

There is more difficulty in applying this substance to coaches and carriages for common roads, so as to preserve a good appearance of the vehicle, on account of the lateral motion that is necessary to be had, than there is in applying it to cars. They have been applied very successfully, so as to ease off the strain from elliptic springs, which may be made light and weak for the purpose, when arranged in the manner represented in the diagram, plate xvii., fig. 8.

* Invented by Mr. E. M. Chaffee, of New Haven.

† Invented by Mr. John Lewis, of New Haven.

‡ Invented by Mr.   of New Haven.

BUFFERS.

These are blocks or springs of gum-elastic, placed between and in front of the cars, (instead of underneath them,) to prevent their jarring by concussion. They are an English invention, and not so generally introduced in America as the car springs, see plate xvii., fig. 9.

CART AND TRUCK SPRINGS.

These are made in the same manner as the car springs described, and are placed underneath various kinds of carts and trucks to be used on common roads. They are placed underneath the body and over the axle of the cart or truck, much in the same way as they are underneath cars. See plate , fig.

WAGON SEAT AND RAIL CHAIR SPRINGS.

These are blocks of gum-elastic sponge, which are placed under the feet of the chairs of railway cars, wagon seats, and the seats of other vehicles. In this manner the seats of all vehicles without springs, may be rendered easy and comfortable, at a very trifling expense.

WHALE SPRINGS.

These are made of elastic cordage, and of one or more gum-elastic ropes, of any size required, with a shackle attached at each end, by which they are to be connected with the cable. The use of the spring is to ease off the strain upon the cable, by which the whale is secured from breaking loose from the ship in

rough weather, while taking the blubber on board the vessel. This invention was suggested by an experienced whaleman; and, although as yet untried, it is more than probable that it is an important use of elastic cordage. See plate , fig. .

DOOR SPRINGS.

Door springs are made of knit goods or elastic compound, in the form of an endless belt, about twelve inches in length, one inch in breadth, and one-eighth of an inch in thickness. They are attached to the door on either side, with the different fastenings, as represented in plate ii., by fig. 5, for the inside, and fig. 6, for the outside of the door.

The elastic ties or letter bands, are sometimes used in the same way for cupboard, bookcase, and other doors. The stayed compound, described on page , made for this purpose, may be used with still greater economy when nailed to gates, or on the doors of out-houses. They answer an excellent purpose at a small expense when properly made.

IMPROVED DOOR SPRING.

Instead of the endless belt above described, a spring may be made cheaper and more durable, of a single strip of gum, about one-fourth of an inch thick, and from one to two inches in width, stayed at each end with a small hose, in the manner described on page . They are attached to the door by inserting the fixtures through the hose, see plate , fig. .

LOCK SPRINGS.

Elastic compound lock springs are the invention of another,* the patentee for the application of vulcanized gum-elastic to car

* Mr. F. M. Ray.

springs. Specimens of door locks have been made by him, as represented in plate xvi., fig. . The springs are simply small blocks of gum-elastic compound, which act by the elasticity of the gum by compression against the bolt of the lock or latch. It is believed that lock springs of this kind will be preferable to steel, on the score of economy and durability, not being liable to rust or to get out of repair.

GUN LOCK SPRINGS.

The use of vulcanized gum-elastic compound for gun lock springs was also the suggestion of another,* and there is good reason to suppose that it will be found useful for that purpose, as it is for car and other springs.

STIRRUP SPRINGS.

This article is manufactured by inserting a piece of the stayed compound fabric into the stirrup leather, near the stirrup. The spring should be of the same width as the stirrup leather, one-quarter of an inch in thickness, and from one to two inches in length to suit the customer.

The stirrup leather may be either of animal or vegetable leather.

The horseman will find this an improvement tending to his comfort. See plate , fig. .

* Mr. John Greacen, Jr., New York.

UMBRELLA SPRINGS.

This is one of the uses to which braided cord of native gum, had been applied for some years in Europe, previous to the manufacture of vulcanized gum-elastic in America. It is a convenient and useful article, like the glove spring, whether made of the native gum or vulcanized gum-elastic.

ELASTIC BANDS.

These bands are either endless belts, or rings of elastic compound. They are used for various purposes, for files of papers, for covering with ribbons for ladies' elastics, and for elastic garters without covering, for securing small packages, and also the covers upon small boxes, and for memorandum and pocket-book fastenings.

In many other cases, for the temporary binding and tying of articles, they are found very convenient. See plate , figs.

ELASTIC TIES.

These bands or ties are manufactured from sheets of gum-elastic drapery or compound, which is first made into tubing of a suitable size, and then cut up into rings, or endless ties, by machinery. They are found very useful and convenient for druggists and tradesmen, for tying up small packages of every description. When receptacles are kept by house and shopkeepers for the preservation of these ties, they will not be found very expensive, taking into account the saving of time in tying and untying. Besides, the price will become reduced, by improvements and facilities in the manufacture, as well as by a larger demand. The

writer is of opinion that when better known these ties will be considered an indispensable convenience for house and shop-keepers, even if they are not quite so cheap as common pack-thread. These remarks are not applicable to their use for heavy packages, as they would not only be too expensive, but too elastic for such a purpose.

IMPROVED HOSE TIES.

When the tubing of which the ties, above described, are manufactured, is made with a stay of cloth about half an inch wide, running its whole length; if, instead of being cut up by the machinery into fine thread, it is cut into rings or bands from one-fourth to three-fourths of an inch in width, elastics and endless springs will thereby be formed with stays, by which stays they may be stitched on to pocket-books, or buttoned or stitched on to hose, or any other article, from which, when attached, the ties need not be removed, except to wash the articles. See plate , fig. .

GIRTH SPRINGS.

These are made of perforated stayed compound, of different widths, to be inserted in girths, surcingles, &c. for the purpose of giving them elasticity. See plate , fig. .

HINGE SPRINGS, OR SPRING HINGES,

Are made of elastic stayed compound. Their use, and the method of their application, may be understood by reference to the description of air and water-proof trunks and boxes, described, Chapter , page .

ELASTIC TAPE.

This is cut from sheets of elastic compound, from one-quarter to one-half of an inch in width. Among other uses for it, is that of tying ladies' hair without danger of cutting it, for which purpose it is much valued by those who have used it.

GLOVE SPRINGS.

See Appendages of Wearing Apparel, Chapter XVIII.

SHOE SPRINGS.

See Appendages of Wearing Apparel, Chapter XVIII.

IMPROVED SHOE SPRINGS.

See Appendages of Wearing Apparel, Chapter XVIII.

VEST SPRINGS.

See Appendages of Wearing Apparel, Chapter XVIII.

CORSET AND STAY SPRINGS.

See Appendages of Wearing Apparel, Chapter XVIII.

TRUSS AND BELT SPRINGS.

See Appendages of Wearing Apparel, Chapter XVIII.

HAT AND CAP SPRINGS.

See Appendages of Wearing Apparel, Chapter XVIII.

CHAPTER IX.

HYDRAULIC.

Engine hose. Hydraulic presses. Force pumps. Water wheels. Suction hose. Improved spiral hose. Connecting hose. Hydrant hose. Faucets. Reservoirs. Filters.

Some articles which come under this head were made, to a limited extent, at an early day. Hose of some kinds was found useful made of native gum. Hydrostatic beds were also made by spreading India rubber cloths over boxes of water, bottles were also among the first articles manufactured to considerable extent by the Roxbury Company.

ENGINE HOSE.

This is an article which has been made, to some extent, of coated canvas, but which has yet been found to answer but indifferently, chiefly on account of the gum peeling from the cloth. It is expected that gum-elastic felt, and the fibrous fabrics, will be found to remove the objections that now exist. Engine suction hose, which is made upon wire wound spirally, can unquestionably be made to advantage of these fabrics.

HYDRAULIC PRESSES.

Gum-elastic compound felt and vegetable leather, are now being successfully applied for hydraulic rams, presses, &c., as a substitute for animal leather. Those who are acquainted with the properties of these fabrics, will not require for them any recommendation for such uses.

FORCE PUMPS.

The plan of this article, answering to the diagram in plate , fig. , to be made of caoutchouc, was given by another.* This pump has not yet been applied to use, but it is obvious that the great objection which exists in all mechanism, and particularly in pumps, that of friction, is, in this case, almost entirely removed, and in other respects it would appear that this fabric must answer a good purpose for force pumps.

WATER-WHEELS.

These are made on the same plan as elevators before described. They have not yet been practically applied to use, but *certain* inferences may be drawn with regard to their utility, from what is known from the use of the iron chain wheel, which is operated on the same principle; they may be built at so great a reduction of cost, in comparison with other wheels, that the invention appears to the writer to be an important one, especially when it is considered that the size of all other wheels is limited, and that these may be built of any height, to that of a hundred feet or more; consequently, a large power might be

* Mr. Edwin M. Chaffee, Roxbury, Mass.

obtained from a small rivulet, and, in situations and places where it would be extremely difficult, if not impossible, to build wooden water wheels.

SUCTION HOSE.

Hose for different purposes, is made by covering wire wound spirally with gum-elastic. By this method of manufacturing hose, an article is obtained which is flexible to be coiled, and is not liable to collapse. On that account, this is a description of hose which answers in some cases where metal and leather hose will not.

IMPROVED SPIRAL HOSE.

Specimens of hose have recently been made of hemp cord, covered with vellum and wound spirally, which recommends itself on account of superior strength. It is lined inside with canvas to prevent its tearing longitudinally, and is not liable to be cut, and when damaged may be mended by riveting, like leather hose.

CONNECTING HOSE.

This is made of sheets of gum-elastic compound, and has been found exceedingly useful for joints, in connecting various sorts of tubes of other materials, used for chemical and other apparatus.

HYDRANT HOSE.

Hydrant hose is made either of *gum-elastic felt*, coated canvas, or *vegetable leather*, and is already becoming extensively used in the United States. The substance being so admirably adapted to this use, it was at first manufactured more extensively than other articles, and from being improperly made of coated cloths, the credit of the article was impaired by the gum peeling from the cloth; but recently the article is highly approved.

FAUCETS.

Faucet valves and stops have been described in Chapter VII., besides which faucets of various kinds, and especially taps and faucets which have heretofore been made of wood, may now be made wholly of vulcanized gum-elastic materials.

RESERVOIRS.

Cisterns and tanks may, for many purposes, with economy be lined with gum-elastic, but the reservoir or tank here alluded to, is made of gum-elastic fabrics, so manufactured that it will be elastic, and not burst when water freezes in it. These tanks, or sacks, are designed to be placed under the roof in the attics of dwelling-houses, with hose connecting with the water spout, and

other hose extending downward to the different apartments of the building. The convenience of this arrangement for the supply of rain-water in the rooms, and also for extinguishing fire, must be apparent. See plate , fig. .

FILTERS.

Perforated caoutchouc ivory and whalebone are suitable materials for the strainers of filters, or the filters may be made wholly of these materials instead of metal. Fig. , plate , represent a filter of this kind attached to a flexible water reservoir of gum-elastic.

CHAPTER X.

MILITARY.

Musket covers. Wagon floats. Ambulanche. Powder bags. Provision bags. Pistol holsters. Port-fire cases. Cannon covers. Sword sheaths. Cartridge boxes. Camp blankets. Cannon sponge covers. Sword and pistol covers. Military belts. Canteens. Water tanks. Military caps. Blasting cartridges. Budge barrels. Tents and tent carpets. Bandages. Military stocks. Haversacks. Knapsacks. Miners' knapsacks. Gun and pistol stocks. Air pontoons and pontoon boats. Air pontoons. Pontoon air boats. Air balsor. Air pontoon rafts.

In the early stages of this manufacture, and during the Mexican war, an assortment of articles were made for the government of the United States. They were made to order in great haste, before the best gum-elastic fabrics for such purposes were invented, and they were manufactured chiefly from the coated cloths, which were not found to answer the purposes of leather, as the fibrous fabrics *have done* since that time. It is not surprising, therefore, that mistakes should have been made in the first attempts to introduce some articles for the use of the army and navy. Nor is it surprising that some articles that are now known to be useful, should then have been imperfectly manufactured, and consequently have failed at that time to answer the expectations which were formed of them. Many of the articles were highly approved by the troops and officers in the service; among which may be noticed camp blankets, tent carpets, canteens and water tanks, and provision and powder bags.

In consequence of the introduction of the hard compounds and other new fabrics, a new field is now opened for the manufacture of various military articles that have not been heretofore attempted. Owing, also, to the invention of vulcanizing in moulds, many of these articles that have formerly been made of sole or harness leather, may now be made by this process, and they

are a class of articles for which no objection can be raised to the use of gum-elastic. Among these are pistol holsters, sword sheaths, cartridge boxes, &c. some of which are hereafter described.

MUSKET COVERS.

Musket covers are manufactured of the plated gum-elastic fabrics, and are secured in the usual way by buckle and strap, or by tying, see plate xii., fig. 1. When fastened by the whalebone slide, as represented by fig. 2, and inflated by the self-acting valve tube, they are not only sufficiently buoyant to float the gun or rifle, but will also answer in a good degree as a life-preserver to the sportsman or soldier, in crossing a river. This article, when used together with the canteen, made with the valve, as represented plate , fig. , is quite sufficient to buoy up a man in the water.

WAGON FLOATS.

These are the invention of an officer* of the United States' army.

The India rubber cylinders are used in pairs with apparatus, represented in plate , by which loaded wagons are easily floated across rivers.

The cylinders may also be used for rafts, and for making floating bridges, when placed at suitable distances from each other, and anchored.

A complete set of these have been furnished to the United States government, for the army.

For a more particular description of the use of these floats, the reader is referred to Col. Stanton's Specification of Patent, United States' Patent Office. See plate , fig. .

* Col. Henry Staunton.

AMBULANCHE.

This is an invention for the purpose of transporting the sick. It consists of a matress or sacking of perforated elastic compound, or of ventilated quilted fabric, as represented, plate , fig. . It is arranged so as to be supported by elastic springs, and may be suspended by different methods, on wood or metal frame-work, or laid upon the ground to suit the convenience or comfort of the patient. As yet, the writer has had no opportunity of testing the utility of this article; he, however, submits it as worthy the attention of military men. "The use of gum-elastic for this purpose was first suggested by an officer of the United States' army."

POWDER BAGS.

These are made of coated canvas, plated and corded fabrics, or vegetable leather, and are used in the army and navy instead of barrels, for containing powder. When the mouths of these bags are secured by the metal fastening, as represented in plate xii., fig. 3, powder will remain dry in them although kept under water.

PROVISION BAGS.

These are made of corded and barred fabrics, or plated canvas, with eyelets to lace, and also with an apron, or extra mouthpiece, as represented in plate , figs. 1 and 2, which falls inside when laced, or is drawn out and tied when it is designed to make the mouth water-tight, or to cause the bag to hold an extra quantity. These bags are useful not only for provisions, but for other merchandise and for papers, to protect them from

loss or damage by water. When the mouth is tied quite tight, these bags may be left in the open field, and even under water, with safety. They were extensively used and approved by the troops of the United States government during the Mexican war.

PISTOL HOLSTERS.

Pistol holsters are manufactured of caoutchouc whalebone combined with vegetable leather. See plate , fig. . The advantages claimed for this article over leather are cheapness, keeping their shape under all circumstances, together with their water-proof qualities.

PORT-FIRE CASES.

Port-fire cases are manufactured of caoutchouc whalebone or whalebone board. See plate , fig. .

CANNON COVERS.

These are made of plated, corded, and barred fabrics, and are designed to be used instead of pent-houses, to protect guns when mounted, and their carriages, from the effects of the sun and weather.

SWORD SHEATHS.

Sword, bayonet, and knife sheaths are made either of caoutchouc whalebone or whalebone board. Their great superiority over leather consists in their cheapness, durability, and in not being so liable to get broken by being bent as leather. See plate xii., fig. .

CARTRIDGE BOXES.

Caoutchouc whalebone and felt are suitable substances from which to manufacture cartridge boxes, of different kinds, using the felt for the belts and other flexible parts, and the whalebone for the parts that have commonly been made of wood or metal.

CAMP BLANKETS.

These are made of napped plated cloths, felt, or corded and napped vellum. They may be recommended as an invaluable article for the soldier, or others who are obliged to sleep on the ground, or are in any way exposed to storms.

CANNON SPONGE COVERS.

These are made of plated cloth or corded vellum, and are used as a cover for sponges that are used in cleaning cannon.

SWORD AND PISTOL COVERS.

Are made of plated fabrics, and are either fastened by buckle and strap, as represented, plate xii., fig. 6; or they are made water- and air-tight by means of the clasp, as represented by fig. 7; by which means, as in the case of the musket covers before described, they are made water and air tight, and the atmosphere is excluded from the arms, so that they are prevented from rusting.

MILITARY BELTS.

A variety of military belts are made of gum-elastic felt and vegetable leather, manufactured after the manner described for other belts and straps, Chapter

CANTEENS.

These are made of plated cloth, *corded vellum, or vegetable leather*, of various patterns and sizes. The crescent shape, represented in plate , fig. , is considered best for the sportsman or soldier, because it does not roll or shift about when suspended upon the person, like some other forms of this article.

Canteens of various patterns are also made of caoutchouc whalebone, but these are more properly described as flasks and bottles in another chapter.

WATER TANKS.

These are made of corded and barred vegetable leather, either single or double, in the manner represented by the drawing in plate , figs. . They are only a larger kind of water bottle, designed for the transportation of liquids of any kind, so trimmed that they may be conveniently handled, or transported on horseback like saddle bags. They were extensively used, and with entire satisfaction, by the United States' troops during the Mexican war. This method of transporting liquids is returning to primitive customs which still prevail in the East, except, that instead of skins, vegetable leather, which is far better, is used.

MILITARY CAPS

May be manufactured in different ways, of any shape desired, of caoutchouc whalebone combined with other gum-elastic fabrics.

Those parts of the cap which are required, may be made soft, like cloth or felt ; and other parts hard, like leather ; while bands of steel or metal may be inserted in their manufacture over the top, to protect the crown from sabre cuts, as represented in plate , fig. ; or wire-work may be inserted in the crown in the manufacture of the article at small expense. With or without these appendages, two important objects are attained in these caps, lightness and strength, and it is believed that by this combination of the fabrics, the article so long desired by military men is obtained.

BLASTING CARTRIDGES.

Are made of elastic compound, with a tube of the same material of any desired length, for the purpose of blasting rocks under water, and for dry blasting, particularly where the bore is to be filled with wet substances. Those acquainted with blasting, and with the properties of this material, will readily perceive the advantages to be gained by cartridges like those proposed.

BUDGE BARRELS.

See Chapter Naval and Maritime.

TENTS AND TENT CARPETS.

See Chapter

BANDAGES.

See Chapter

MILITARY STOCKS.

Since the invention of the perforated fabrics, and the improvement of gum-elastic in relation to odor, among the other articles of ordinary wearing apparel to which gum-elastic is being successfully applied, perhaps no one is more appropriate than that of military stocks. They are, like gum-elastic over-shoes, formed upon lasts, upon which they are vulcanized, consequently they will afterwards retain their shape, will be cool and pleasant, and will be exceedingly durable.

HAVERSACKS.

These are manufactured in two apartments, similar to gum-elastic fish-bags, one of which is made of the perforated, the other of the water-proof fabrics; consequently, the articles in one of them will be protected from wet, and those kept in the other will have the advantage of a circulation of air. See plate fig. .

KNAPSACKS.

Among the first military equipments made of gum-elastic, were knapsacks; they were found objectionable in consequence of their too great warmth, offensive odor, and imperfect manu-

facture. The first objection is removed by perforating different parts of the knapsack; the second, by a change of ingredients in the compound; and the last, by skill and experience in the manufacture. See plate , fig. .

MINERS' KNAPSACKS.

This knapsack is manufactured of gum-elastic plated cloth or vellum, upon the same general plan as the knapsacks before described, with the addition of apartments for the miner's tools.

GUN AND PISTOL STOCKS.

Caoutchouc enamel and ivory are admirably adapted, either alone or in combination with iron or wood, for pistol and gun stocks, and also for the handles of other military weapons generally. There is also an important economy in the manufacture of these substances for these purposes, because they are moulded into the different forms, either plain or ornamental, with trifling labor without waste of material.

AIR PONTONS AND PONTON BOATS.

India rubber pontons and ponton boats, by which is here meant all such as are made of India rubber fabrics filled with air only, were among the first things made of gum-elastic by different manufacturers.

The attention of the United States and other governments was early drawn to them, as being inventions deserving of encouragement. They were favorably noticed, and orders were given by the United States government for supplies, as then manufactured, of native gum. In the commencement of the manufacture of the vulcanized fabrics, orders were repeated for supplies of the vulcanized pontons; but they have thus far failed to be as useful as was anticipated.

The objections which apply to boats and pontons made of gum-elastic fabrics (uncombined with other materials, for staying and stiffening them) and filled with air only, are the following, viz.: They require to be filled with a hand bellows, which is an inconvenient and laborious process. A very small leak will cause them to collapse and sink. These difficulties are overcome by combining the vulcanized fabrics with other materials, in the manner specified in this work for constructing self-inflating air-work. See Chapter , p. .

From these descriptions, and those given in the chapter on self-inflating pontons, the improvements here alluded to may be understood. A brief description is here given of a few of the many forms of pontons and boats which are filled with air only; not for the purpose of recommending them, but for the purpose of giving an idea of the origin of articles of this description.

AIR PONTONS.

The air ponton above alluded to as ordered by the United States, was made of coated canvas, in three compartments cemented together, as represented, plate , page , each compartment being inflated by a separate tube, forming together a raft or boat about six feet wide and eighteen feet in length.

PONTON AIR BOAT.

This boat is formed of a series of air-tubes or cylinders, each of which is inflated with a separate tube. This, together with the ponton above described, may be considered the best among the many kinds of air pontons and boats designed to be filled with air only. See plate , fig. .

AIR BALSOR.

Fig. , plate , represents a balsor or single air cylinder, one of the earliest manufactures of the Roxbury Company. They were made of India rubber canvas, and inflated by a hand bellows. They were designed to be used as a life-spar or buoy, or to be fastened to boats to keep them from swamping. These, as well as the other articles in which air alone is relied upon for their buoyancy and safety, are unsafe and not to be depended upon compared with the self-inflating pontons and boats specified in Chapter XXX. They are here noticed because they were the first of this kind of work, and because they are the cheapest made, and would answer a good purpose in the absence of better things.

AIR PONTON RAFTS.

These may be constructed either of the air balsors or wagon float cylinders. For this purpose they are connected together in the same way as the self-inflating ponton rafts, more particularly specified, Chapter XXX. They are more cheaply made, but not so convenient or safe as the self-inflating ponton rafts. See plate , fig. .

CHAPTER XI.

NAVAL AND MARITIME.

Ships' sails. Report of Captain Popham. Second report of Captain Popham. Ship lights. Tarpaulins. Ships' water tanks. Hammocks. Tompion. Signal balls. Camels, or vessels' lighters. Submarine armor. Ships' letter bags. Bread bags. Sailors' bags. 'Budge barrel. Fenders. Navy belts. Sheaths. South-westers. Tarpaulin hats. Deck scrubs. Gun recoil springs. Shot plug. Life buoy. Harbor buoy. Anchor buoy. Whale buoy. Anglers' floats. Decoys. Seine floats. Sheathing and caulking materials. Bathing tubs. Ships' buckets. Ships' ware and utensils. Seamens' wearing apparel. Improved hatch. Boats. Whale-boats, yawls, jolly-boats, and row-boats. Long-boats. Club-boats and race-boats. Life boats. Ballast tanks.

It is not to be expected that one unacquainted with a sea-faring life, should be able to enumerate, and much less to describe minutely, all the various articles that might be made for ships' use, or that might properly be classed under this head. Those who are acquainted with the subject, and the wants of seamen, will doubtless suggest many other uses, as well as improvements in the construction of those articles that are now made of the gum-elastic fabrics.

SHIPS' SAILS.

The first gum-elastic ship's sail was a top-sail, which was made by the writer in 1844, and was intended for the packet ship Patrick Henry. After the sail was completed, it was thought that the coated canvas of which it was made was so very light, that it was imprudent to make trial of it. It was, therefore, stored at the warehouse in New York until 1845. At this time, the clerks at the warehouse, in a frolicksome mood, and not knowing why the sail had not been tried, had it bent upon the Liverpool packet ship Stephen Whitney ; and, for a surprise to

the writer on the day of sailing, gave him an invitation to go to sea under an India rubber sail. His first emotions were those of displeasure at the conduct of the clerks, but it was too late to unbend it, it fitted well, and it was with feelings mingled with regret, hope, and fear for the result of the first experiment of so important an application, that the writer saw the sail set, and, outside the bay, filled with a stiff breeze.

This sail was made of a cloth very inferior to the light sail duck, and was banded in the same manner as that represented by the plate . The performance of this sail, considering the quality of the canvas of which it was made, as appears from Capt. Popham's reports, was matter of surprise.

Notwithstanding the favorable nature of these reports, the writer was aware that these sails were heavier than would be desirable, as the goods were then made. Since that time the improvement in this respect is such, that the article now appears to be *quite* unobjectionable.

The sail was taken off before the loss of the Stephen Whitney, and sent to Washington for inspection.

The question will naturally arise, why an improvement of so much importance should so long remain without further notice? It may be answered that the best things often remain unnoticed from the fact, that circumstances exist adverse to their introduction; and it sometimes happens that the advantages promised by particular things are so great, as in themselves to stagger belief, and excite incredulity. Such would appear to be the case in reference to the use of this substance for ships' sails, and this application has undoubtedly been delayed chiefly on that account.

It was not, however, wholly unnoticed as has been generally supposed. Orders were given by the government for several suits of these sails, through Col. Staunton, who superintended the equipment of vessels for the Mexican service. The principal reasons why the orders were not executed, were these: Orders

for quantities of smaller articles, the manufacture of which was more lucrative to the licensees, were being executed at the time for the government. The manufacture was not then sufficiently advanced as to the extent of the heating or vulcanizing apparatus, for the manufacture of sails. The substituting of the fibrous cotton fabrics for this use instead of duck, will not only lessen the expense so as to make the sails cheaper, but when corded and barred, will also make them stronger than duck.

Their being made white will give them almost exactly the appearance of other sails. Owing to the advancement of the manufacture, the article has been greatly improved since the sail for the Stephen Whitney was made, being manufactured much lighter, and more complete in many respects. It is certain that there can be no loss of power by the escape of wind through these sails, consequently, the spread of canvas required will be much less; and vessels with these sails will be less difficult to manage, and much more safe. Increased strength may be gained by cording the sail with large twine, and by making the bars of linen web. In this way an almost impassible barrier is presented to the tearing of the sail beyond each bar; whereas, a sail of duck, when it begins to tear is often rent the whole length or breadth.

The comparative durability of the two kinds of sails is too obvious to be discussed; but the superiority of the gum-elastic sail, not being liable to mildew and decay like canvas, may be noticed.

The peculiar property of these sails, and one upon which emphasis may be placed in describing it, is pliability. They will not stiffen and freeze, as will be seen in the report of Capt. Popham; and any one may easily ascertain by trial, that ice will not adhere to gum-elastic fabrics. This being the case, the danger is less, and much labor and hardship in working them is saved.

This is perhaps the most extensive and important of all the applications of gum-elastic, is one of national interest, and the subject is worthy of an abler pen. The writer would here

appeal to all whom it concerns, not to leave unheeded that which so deeply affects the interests of mankind.

Plate xi., fig. 1, represents sails that are made of barred coated canvas, such as was tried upon the Stephen Whitney. Plate xi., fig. 2, represents sails made of the corded and barred cotton fibrous fabrics, with which experiments are now being made for sails, which it is believed will answer better than duck, on the score of both cost and quality.

REPORT OF CAPTAIN POPHAM.

New York, *January 9th*, 1846.

Mr. Charles Goodyear.

Dear Sir,

It gives me pleasure to say, in reply to your letter, I can state decisively that your metallic India rubber canvas is a superior article for ships' sails, and especially for heavy and storm sails.

The topsail in question was put on the packet ship Stephen Whitney, in May, 1845, since which time it has been constantly and severely tried during three passages across the Atlantic, both winter and summer. Among its many good qualities, that of its remaining pliable and clear of ice when other sails are frozen and stiff, is deserving of special notice

I shall be able to speak further of its durability, if it ever wears out. That a canvas so inferior as this was, before it was covered with your gum-elastic, should endure service as this has, is to me a matter of surprise.

Charles W. Popham,
Of Ship Stephen Whitney.

SECOND REPORT OF CAPTAIN POPHAM.

NEW YORK, *May 9th*, 1846.

CHARLES GOODYEAR, ESQ.,
New Haven.

Dear Sir,

With much pleasure I again reply to your inquiries respecting the patent India rubber sail. It has now been with me six successive trips across the Atlantic, and I can assure you has received no favor. It appears to me to possess great durability, is easily handled in wet or frosty weather, not being stiffened in the least degree by either the one or the other, and is also not liable to mildew.

I consider your invention valuable to all engaged in ocean navigation.

I am, dear Sir,
Yours truly,
CHARLES W. POPHAM,
Of Ship Stephen Whitney.

The sail was taken off before the loss of the Stephen Whitney, and sent to Washington for inspection, when the orders for sails for government vessels before alluded to, were given by Col. Stanton.

SHIP LIGHTS.

The use of gum-elastic for ship lights is the invention of another,* for which he obtained letters patent. The improvement in this article consists in placing a cushion, or packing of gum-elastic, around the metal sash upon which the lid or cover of the light shuts, for the purpose of keeping out the water in rough weather, the importance of which will be readily perceived. The construction of these lights may be better understood by reference to plate , fig. .

* Mr. Enoch Hidden, New York.

TARPAULINS

These are made in the form of hatch covers, hammock covers, and other articles, of corded and barred vellum, and the plated fabrics.

For this use, as well as all others, when the fabrics are constantly exposed to the action of the sun and weather, a large proportion of carbon or lampblack is required to be compounded with the gum.

At the time of the first manufacture of the vulcanized fabrics for such purposes as the above, this fact was not known, and the articles did not prove as good as was expected; but it has since been proved beyond a question, that with the addition of carbon, this objection is removed. The fabrics are yet further improved in this particular, by giving them a surface coat of caoutchouc, compounded with shellac.

SHIPS' WATER TANKS

Are made of corded and barred plated fabrics, in the form of a barrel, with or without a hose and stop-cock attached, as represented in plate , fig. .

It is satisfactorily proved by long trial, that water may be kept in these vessels a great length of time without injury. Another great advantage they have is that of compact storage, and of more convenient transportation than barrels, or other wooden or earthen vessels, for taking water on board from the shore by boats. It is apparent that these tanks may be made of any dimensions for containing water on shipboard, and that their buoyancy when filled with air instead of water, might be made available on many occasions in forming life boats or rafts.

HAMMOCKS.

Hammocks are manufactured of the perforated and quilted fabrics, described Vol. I. They are well suited for ships' use. The superiority claimed for them consists in their cleanliness. They do not require to be scoured, and are not liable to be infected with vermin. The article is made more complete by the addition of a sheet of napped vellum, of the size of the hammock, which may be drawn underneath it in winter, so that the article when arranged in this way, may be considered warmer in cold weather, and cooler in hot weather than other hammocks; and if the perforated gum-elastic compound is used, (instead of the other fabrics which are not elastic), a hammock is formed as comfortable as can be desired, although it will be more expensive than that made of the non-elastic fabrics. See plate , fig.

TOMPION.

The outer surface of this article, for the depth of about an inch, is made of gum-elastic sponge; within it is filled with air or light wood, and is designed as a substitute for the wood tompion, which has been heretofore used. Its use is to keep cannon dry and free from rust. This is the invention of an officer, formerly of the United States' Navy;* it is evidently an improvement, and may be termed a perfect cannon cork.

SIGNAL BALLS.

These are made of plated fabrics, about three feet in diameter, and are constructed in the same manner as the self-inflating globes before described. They are designed for signals for ship's

* Lieut. Seeley.

use, and were first made of gum-elastic, by order of Commodore Smith, of the United States' Navy, for the use of government vessels.

CAMELS, OR VESSELS' LIGHTERS.

This use of gum-elastic is the invention of another,* as patented by him in the United States, for lightering vessels in shoal water. They are made of corded caoutchouc fabrics, surrounded by a rope netting, and are applied to the vessel in the manner represented, plate . Several sets of these camels have been ordered for the United States' vessels, for experiment.

SUBMARINE ARMOR.

This consists of a dress and apparatus, made chiefly of vulcanized gum-elastic fabrics, an idea of which may be obtained from the plate. This armor was invented and patented by the patentee of the ships' camels, described above.* It was designed as a substitute for the diving bell, and was also intended by the inventor to be used for pearl diving, for which purpose there is good reason to suppose it might be used to advantage. See plate

SHIPS' LETTER BAGS.

These are made in the same manner, and of the same materials, as the mail-bags, described page , except of a larger size; the value of this article for the preservation of life and property is not commented upon here, as this is more particularly noticed under the head of Articles for the Preservation of Life

* Capt. George W. Taylor.

and Property, Chapter . Another article of this kind is made with an air-tight clasp, and tube for inflating it, see plate , figs. 1 and 2.

BREAD BAGS.

Are made in the same way as ships' letter bags, of gum-elastic fabrics ; they are designed for containing bread for ships' use, instead of barrels, by which means bread may be kept dry, and room saved in storage.

SAILORS' BAGS.

These are made of plated cloth, or corded vellum, with water-tight mouth pieces, in the same way as the grain bags, described page . They are made of different sizes and proportions, and without handles, but commonly of the proportions required to answer the United States' Navy regulations, where they have been used with success.

This article is designed not only to answer the purpose of a clothes bag, but also to render any boat, even though it should be leaky, a life-boat, which may be done by lashing to the boat a number of them filled with clothing.

BUDGE BARREL.

This is a light cask or barrel, made of whalebone board, with wooden hoops, as represented in plate xii., fig. 1; it is an article which has heretofore been made of leather, and is used for the safe keeping of cartridges on deck during an action.

FENDERS.

Boat or vessel fenders are made of gum-elastic sponge, either in the form of a ring or cushion, see plate , fig. , or they are made of heavy vegetable leather, and inflated with air, as represented, fig. , in which case they form one of the assortment of articles for the preservation of life for ships' use.

NAVY BELTS.

These are made of vegetable leather, with pockets for cartridges, and appendages for the knife or sabre, and revolver. See plate xii., fig. 2.

SHEATHS.

Knife and sword sheaths are most completely made of caoutchouc whalebone and whalebone board. This substance is peculiarly adapted for this use, and particularly on shipboard, both on account of its pliability as well as water-proof qualities. See plate xii., fig. 3.

SOUTH-WESTERS.

This is a cap made after the pattern well known to fishermen and sailors by the above name, as represented in plate , fig. . They were formerly made of painted canvas, instead of which those made of India rubber fabrics are fast coming into use.

TARPAULIN HATS.

Are best made of vellum or vegetable leather. They are much lighter, and much more durable than those made of painted canvas, but whether they will be adopted by Jack instead of the article made by himself, during his leisure moments, is a matter of doubt.

DECK SCRUBS,

Or what are termed by sailors Squeal Gees, are made of a plate of caoutchouc packing, such as is used for engine packing, or of gum-elastic sponge. This article has already been made by one of the licensees* to considerable extent, and has been found to answer the purpose for which it is used, completely. See plate vi., fig. 7.

GUN RECOIL SPRINGS.

The strain and injury done to vessels of war by the recoil of the guns, is an evil for which a remedy has long been sought. For this purpose it has been proposed to use springs of gum-elastic, acting either by extension or by compression : in either case, various methods may be suggested for applying them to the gun carriage. See plate , fig. .

* Mr. John Greacen, 98 Broadway, New York.

SHOT PLUG.

As this article appears to be deserving of special notice, and one that would not be likely to be understood without particular explanations, a description of it is given in full from the inventor's* advertisement, which is as follows:

" This invention is, without doubt, one of the most perfect, ingenious, and valuable articles ever patented in the world; and for simplicity and usefulness, unequaled for the purposes intended, viz.: for stopping the holes made by cannon balls in the sides of ships, and for other purposes, as named in the following description. Fig. 1, plate , represents the Shot Plug, in a contracted state, and ready for immediate use. In time of action, it requires the attention of but one man in each wing of the vessel, as in a few seconds the plug can be thrust through the hole, as soon so the ball enters. The ring is then drawn off by the lanyard attached, it then expands by a spring, and forms a flap-valve, which is acted upon by the pressure of the water from without, and securely fastened on the inside of the ship, no matter how much splintered, by the buckler and screw on the end of the shaft, thus forming an impregnable barrier to the entrance of water.

The advantages this Shot Plug have over the old conical or wooden plug are various. It supersedes the necessity of sending carpenters over the sides of vessels, when in action, to insert the wooden plug, whereby they are continually exposed to the enemy's sharp-shooters, and frequently lose their lives; and when the ball enters below the water-line, the hole cannot be stopped from without, but is secured in the best way possible on the inside, by the substitution of oakum, tallow, or any thing that comes handy, and never can be made tight.

Another feature. and a very important one in this invention is, that when inserted it does not retard the sailing qualities of

* Lieut. Seely.

the vessel. The conical wooden plug always projects from the side of the vessel one or two feet, necessarily retarding its motion in a very great degree. It also has the advantage of deceiving the enemy, as it can scarcely be noticed either after or in being inserted.

This Shot Plug can also be used with the same facility in stopping air ports, or side lights, when by accident they are broken; dead lights, horse pipes, when the cables are unbent; pipes passing through the sides of steam vessels, which are liable to injury; also holes caused by snags, or other accidents of the kind.

Fig. 2 represents the Shot Plug in an expanded shape, and is better described and explained by the following remarks, having reference to the letters designating its different points from A to G.

A is the conical head into which the outer end of the shaft is screwed. It is made of cast iron, in the shape of a cone, and of sufficient size in length and breadth, having a circular cavity in its large end, forming a curb or ring, for the purpose of receiving and protecting the joints of the springs, and forming a shoulder or stop, against which the wings strike when expanded.

B is a centre plate or ring, circular or many-sided, to which a number of springs are attached, having an opening in its centre to admit the shaft, over which said plate or ring is slipped, and secured by the head and shoulder, as represented in description A.

C is ten or more slightly curved radial springs, of any desired length, hinged to the central plate B, made flat, and slightly tapered and widened outwardly, and also curved at their extremities, to prevent their catching in the ship's sides.

D is the central cylindrical shaft, which is passed through the circular plate to which the springs are hinged, and screwed into the conical head represented by A. This shaft has a screw cut on each end: one for the conical head, the other to receive the wrench by which the shaft is drawn inward through the buckler, represented on the shaft of the contracted Shot Plug in first cut.

This shaft is jointed at the upper letter D, so as to admit of its being applied with the same facility, and effectually stopping the leak from a shot hole, no matter in what direction the ball may enter the ship.

E is a circular vulcanized spring, made of stout, heavy India rubber packing, possessing sufficient power to force open the springs attached to the centre plate or ring, causing the flap-valve to expand, and immediately cover the hole, effectually shutting out the water in an instant.

F is a circular sheet of vulcanized India rubber cloth, attached to and covering the radial springs, with a hole in the centre sufficiently large to admit of the shaft passing through, to be attached to the conical head.

G is a circular ring, with lanyard attached. This ring is represented in the first engraving, placed in its proper position on the Shot Plug, to prevent its expanding before passing through the shot hole. It brings the entire springs and covering into a compact and proper shape, to protect the cloth from splinters, or from being torn in passing through the cavity. After the plug is thrust through, the ring is drawn off by the lanyard, the springs expand, and the pressure of the water, and use of the screw and buckler, secures it tightly, and excludes the water as effectually as though the hole was boarded and caulked.

SAMUEL J. SEELY."

LIFE BUOY.

This is made of any required shape or dimensions, of vegetable leather, in the same way as self-inflating air work. It is inflated by a self-acting valve tube, and when thrown overboard, being attached to the vessel by a rope, it will become self-inflated.

This is an article which may be recommended to be kept as a life buoy on the deck of all vessels. See plate , fig. .

HARBOR BUOYS.

It has been suggested that harbor buoys may be constructed of vulcanized whalebone board, with economy and advantage, especially for southern latitudes, where wooden buoys are exposed to the ravages of insects. The metal buoys which are now used are very much heavier, and much more expensive than they would be, made of gum-elastic cord ware. The writer has no doubt as to the success of an article of this kind, if properly made of this material in this way. See plate xi., fig. .

ANCHOR BUOYS.

These articles are made of plated canvas or whalebone board, with a ring at each end working on a swivel. For ships, the size is commonly about three feet in length and eighteen inches in diameter, of the shape represented in plate xi., fig. 7.

WHALE BUOYS.

Are made of vegetable leather, or cord ware, about fifteen inches in length and eight inches in diameter, with a wooden block at the end through which the harpoon line is passed. A tube is also inserted in the block with which to inflate them. This article is fast displacing the leather ones formerly used by whalemen. The object for which it is used is to save the harpoon and line when the whale is missed in harpooning. See plate xi., fig. 3.

ANGLERS' FLOATS

Are made of elastic compound, after the manner of hollow ware. They are designed as a substitute for the small wooden and cork buoys that are commonly used with fish lines. See plate xi., fig. 4.

DECOYS.

These are made for sportsmen, of non-elastic compound or whalebone board, after the manner of hollow-ware and toys in moulds. See plate xi., fig. 8.

SEINE FLOATS.

These are made of whalebone board, of an oval shape, after the method of hollow ware. A tube or hose of the same material passes through the buoy, and is cemented to it at each end. The seine rope is passed through this tube in attaching it to the seine. The advantage proposed by these floats is lightness, for which reason the seine can be more easily dragged, and will not be worn by handling, as in the case of wooden floats, which become water-logged and heavy, see plate xi., fig. 5.

SHEATHING AND CAULKING MATERIALS.

See Chapter Packing, Sheathing, and Caulking.

BATHING TUBS.

See Chapter Bathing Apparatus.

SHIPS' BUCKETS.

See Chapter Ships, Camp, and Kitchen Utensils.

SHIPS' WARE AND UTENSILS.

See Chapter VII.

SEAMEN'S WEARING APPAREL.

See Chapter Wearing Apparel.

IMPROVED HATCH.

The hatch of vessels may be improved and rendered safe and water-tight by the use of vulcanized India rubber packing set around in the sill of the hatch. A projection or ledge is formed upon the hatch cover, which shuts upon the packing when the hatch is closed, by which means it is made perfectly water-tight.

BOATS.

The magnitude of the consequences depending on the proper construction of boats and vessels, demands that all should be done that is possible to this end, and although apparently all has been achieved that could be, with the materials that have been used in the ordinary methods of construction, yet it is more than probable that with other materials and methods of combining them, further improvements will be made in this art. That the caoutchouc fabrics, whalebone and whalebone board, are the new materials with which boats of different kinds will be greatly improved, there is good assurance. The strength and elasticity of these materials, together with their extreme lightness, renders their usefulness for this purpose a matter of certainty. In the building of large boats, such as ships' long-boats, their strength will be increased by the use of the whalebone board, in the form of tubes, in the manner hereafter described and represented in plate . For other boats, this substance is strong enough in the form of sheets, much stronger than any kind of wood of the same weight; nor is it necessary to give it a tubular form for boats of any size, except to make them much stronger than wood, with the least expense.

In making suggestions for the adoption of new materials, and new combinations of them, for the building of vessels of a large class, some circumstances which have led to these suggestions are stated, lest it should be thought that the subject is wholly foreign to the writer's occupation.

It is so ordered as a general rule, that individuals of one occupation cannot easily encroach upon that of others, or make improvements in branches of business with which they are disconnected.

There are, however, exceptions to this rule. As some nations are so strongly attached to particular customs, and fixed habits of thinking and acting, as almost to prohibit all advance in science and the arts among them, so different classes of trades

and mechanics sometimes become so wedded to the method of doing things in the way they have been taught, and their interests become so blended with the existing state of things, that of all persons they are least likely to discover any improvement that produces a change, or makes an innovation in their branch of business.

An observer, whose mind is free from bias of any sort on the subject, may therefore, in some cases, by research, and by applying his energies to a single point, come in possession of advantages, connected with his experience in other matters and pursuits, which more than counterbalance the disadvantages under which he labors, for the want of knowledge of the new art or profession in which he engages.

The year before the writer commenced his experiments with India rubber, he was occupied with attempts in the improvement of boats, by constructing them of metal tubes upon a plan very similar to the one hereafter described. A difficulty was then found in combining and securing the tubes together, so as to make them water-tight. The improvements in caoutchouc manufacture, consequent upon the discovery of the vulcanizing process and the invention of the whalebone board, render the manufacture of boats upon this plan now both practicable and simple. When the art of forming metal tubes shall be sufficiently advanced, so that they may be readily shaped to the model of a vessel, it is believed, that by the method of combining them, represented plate , vessels may be built of metal tubes or cylinders instead of sheets or plates of iron as heretofore.

Since the time of the experiments before alluded to with metal tubes, in 1834, great advancement has been made in the art of building boats and other vessels of iron; but this plan of using the iron in a tubular form, and particularly the method of uniting and binding the tubes, was then, and is even now, quite new.

As an argument from analogy in favor of this plan of building with tubes or cylinders, whether as applied to boats or ships, it may be said that the frame-work of the whole vegetable creation is cylindrical. The greatest portion of the bones of all

animals, and especially of birds, is of the same shape, and hollow. This is the form which the Creator has adopted in his works (as best exemplified in the case of birds), where strength, speed, and buoyancy are requisite; why should it not be adopted in the building of vessels, where the same qualities are necessary?

At the time the writer made his experiments in boat-building with metal tubes in New Haven, in 1834, he firmly entertained the opinion of the correctness of this theory, and he is now fully convinced of its practicability, and that great improvements will be made in boats and vessels by this method of construction with tubes. These experiments were pursued during that year with the same ardor, and subjected him to the same kind of ridicule from those who witnessed them, as subsequently attended his experiments with gum-elastic.

These efforts at boat-building resulted in the completion of two sail-boats, each about fifteen feet long.

One peculiarity of this method of construction is, that each tube is used instead of a plank or timber in the ordinary way of building with wood. These tubes being each one hermetically sealed, the whole are united together in the manner hereafter specified in the article on long-boats, and as represented in plate . Another peculiarity is the use of metal, copper, or brass for the tubes, instead of iron. It is assumed that the increased strength of sheets of these materials, arising from their being used in a tubular form, will more than compensate for the difference in strength between them and iron, when iron is used in the form of plates, so that even the first cost could hardly be greater than that of iron as now used, in which case a vast economy is obvious. These finer metals used in the form proposed, could seldom be lost, even in the case of wreck they would float somewhere, and not being liable to corrode, like iron, the parts of an old vessel would always be of nearly the same value as when new.

It is not yet known to what extent caoutchouc may be used in the construction as well as the equipment of ships. Upon

this plan of constructing with tubes, it may be used in the construction of ships as well as of long-boats, when the supply of the substance shall be equal to so great a demand. Notwithstanding there is a sufficient supply in nature for such a demand, the means are not yet applied for gathering it to a sufficient extent. This plan of construction, however, is equally applicable, whether the tubes are formed of whalebone board only, or of sheets or plates of iron or finer metal covered with caoutchouc whalebone board. In the first attempts to build a vessel or long-boat, they would be constructed with less difficulty by continuing the tubes entirely around the model, and forming the bows and stern of plates of metal, as represented plate , figs. .

The foregoing suggestions are made for the consideration of those who may deem them worthy of notice, not doubting that at a future day they will receive attention. However speculative these views may appear to some, in regard to substituting these materials in vessels of a large class for timber, their correctness is already clearly demonstrated as applied to boats. A description of some of these is briefly given in this work.

The description of a variety of fancy and portable boats, and also of portable life-boats, are given in Chapter of this volume, the object is here only to describe those designed for common use for vessels, such as yawls, long-boats, row-boats, etc.

The hard compounds, whalebone and whalebone board, in sheets, (without being first made into tubes,) are strong enough for row-boats and the small boats of vessels. They are superior to boats made of wood, on account of their lightness and perfectly water-proof qualities, and may be made of one entire sheet of uniform strength.

The seams, of which there are but one or two in the covering of a large-sized boat, are the strongest parts of the work, being those parts in which wooden boats are most defective, and on which account chiefly they are unsafe, whereas boats of these materials are so cemented and united as to form one entire piece. This substance for boats may be described as a plastic wood, which, when in a soft state, may be shaped into any form

of uniform strength, in which form it is vulcanized, which form it retains with this advantage over any natural wood of the same bulk or weight, that it is harder, more elastic, and firmer. See plate , fig.

WHALE-BOATS, YAWLS, JOLLY-BOATS, AND ROW-BOATS.

All these various kinds of boats are made of the same materials, they are manufactured in the same way, and the same advantages appertain to them all in a greater or less degree, therefore the following description of the manner of their construction, with the plates, will serve to give an idea of the whole. The gunwale knees and keel are made either of wood or iron, and covered with thin whalebone board, or they are formed of tubes made of thick whalebone board. They are cemented to the boats after they are formed in the following manner:—The sheets of vulcanized caoutchouc whalebone board being made from one to two yards in width, and of any length desired, are cemented together upon the outsides of a form or model of the boat, in the same way as a shoe is formed upon a last, the keel being cemented on afterwards. The boat is then taken off and placed inside another form or mould of the same shape, when the parts before described are cemented to it, the whole is then vulcanized in the mould. See plate , figs.

LONG-BOATS.

Boats of large dimensions, and ships' long-boats, may be made stronger of these materials by first forming the whalebone board into tubes of from two to four inches in diameter, or of such dimensions as are best suited to the size of the boat. When put together, the tubes are shaped upon a model to the form of the boat, and cemented together. They are also cemented to the stem and stern pieces, each tube being made separately water-

tight. The spaces between the tubes are filled by triangular-shaped pieces of wood or battings, grooved so as to fit between the tubes. These pieces are placed longitudinally between the tubes, both outside and inside.

In order to make the whole structure water-tight, and to give the boat greater strength, these battings are covered with caoutchouc and cemented in their places. They also serve to form a smooth surface both outside and inside the boat. These battings are further secured by bolts passing through them and between the tubes of the boat. The gunwale knees and braces are secured in the same manner as the boats before described.

It will be perceived that this combination of the materials is such as to give the greatest possible strength with the least weight. This description may be better understood by reference to the plate, fig. .

CLUB-BOATS AND RACE-BOATS.

Caoutchouc whalebone and whalebone board are materials exactly suitable for the manufacture of club and race-boats, on account of their great strength and lightness, and the cheapness of their manufacture. Thin whalebone board may be used in general for club-boats, but caoutchouc whalebone will make the lightest and most completely finished race-boat. See plate , fig. .

LIFE-BOATS.

All the boats before specified are convertible into life-boats with trifling expense at the time of their manufacture, by the addition of water-tight compartments in the waste room in the bottom and sides of the boat, as also at the stem and stern, as represented by plate , figs.

The long-boats before described are necessarily life-boats, as they are first made of tubes, but they also may be rendered

still more buoyant by the addition of compartments. See plate , fig.

For further descriptions of a variety of portable boats and portable life-boats, see Chapter

BALLAST TANKS.

It is suggested that an important improvement may be made in the method of giving ballast to boats and vessels, by the use of large tanks made of caoutchouc fabrics, to be placed in the bottom of the vessel or boat.

These bags may be so arranged with connecting hose, that the water may be pumped in and out. At the same time the fresh water of the vessel may be taken in these tanks, instead of being taken in hogsheads, in which case it is apparent there would be a great saving of room and labor.

CHAPTER XII.

MEDICAL AND SURGICAL.

Bandages. Hospital air beds. Hospital water bed. Improved water beds. Hospital sheets. Dissecting gloves. Dissecting aprons. Finger ends, or cots. Crutches. Russian belts. Abdominal supporters. Trusses. Ear trumpets. Varicose stockings. Nipple shields. Breast pump. Nursing bottles. Poulticing socks. Urine bags. Gonorrhea bags. Bed pans. Pessary. Syringes. Bellows syringes. Self-acting syringes. Invalids' cushion. Ventilated water-beds. Stethescopes. Hot-water bottles.

It has been remarked that the medical faculty were among the first who gave attention to experiments for the purpose of improving gum-elastic, and next to the erasing of pencil marks, it was used for medical and surgical purposes. For some of these purposes, articles rudely manufactured of native gum by the Para Indians, have been highly valued, though they are now mostly superseded by an increased variety of others in this line, made of vulcanized gum-elastic. Some articles spoken of in this chapter, which are of the highest value, are hardly known to the mass of mankind, even in highly civilized life, for various reasons.

The expensiveness and only occasional use of such apparatus, has been a hinderance to their general introduction. Among this apparatus, the merit of which is not commonly known, are the hot-water bottles, water beds, and hospital sheets. The water beds cannot be too highly recommended for invalids, as they will oftentimes afford rest when no other bed will do it. The bed-spreads and hospital sheets are equally useful in their place, and probably no means are so convenient and effectual for fomentation as the hot-water bottles. The extensive manufacture and general use of this class of articles, would reduce them to a comparatively nominal expense.

BANDAGES.

Stayed compound drapery, medicated drapery, and perforated felt, and fibrous fabrics, which may be found in the piece at the shops, are highly approved for bandages in many cases. Perforated gum-elastic knit goods may also be used for the same purpose. Perforated knit goods are sometimes preferred for bandages, because they may be stitched to fit the limbs, and possess greater strength than drapery. A piece of any size to fit the limb, being cut from the elastic knit goods, perforated fibrous fabric, or felt, will commonly be found the cheapest and best bandage for lame, rheumatic, or sprained limbs, or to wear around the body. The great objection to India rubber bandages has heretofore been excessive warmth. This is obviated in the perforated goods.

When the design is to sweat or foment the limb, or when these bandages are to be used in the army, navy, or elsewhere, for the stoppage of hemorrhage, medicated drapery, *not perforated,* will be found cheapest and best. These bandages are highly approved for the above purposes, and may be recommended as a truly useful article; but in chronic affections, or gout, as has been remarked, in the description of medicated drapery, these fabrics produce no good effect.

HOSPITAL AIR BEDS.

This name is applied to these beds, because they are particularly adapted for the comfort of invalids; at the same time the opinion is entertained that they are better calculated for common use, and particularly for ships' use, than any other kind of air bed. They are made of gum-elastic, vellum, or knit goods, in separate cylinders, or what might equally well be termed life-preservers, because, when trimmed for the pur-

pose, they are really such, and answer quite as well as those which are sold expressly for that purpose only. The cylinders, being placed parallel to each other, are buttoned to a strap, as represented in plate vii., fig. 1, or they may be covered with a case, or tick, of the common sort, or of coated cloth, or vellum. These beds have one very great superiority over those in which the compartments are connected, as they can be easily repaired. When one cylinder is damaged by a small leak it can be detected by immersing it in water, when it might be impossible to discover it in a whole bed where all the compartments are connected, and in this case the injury only extends to a fifteenth or twentieth part, according to the number of cylinders. Besides, a damaged cylinder may be replaced by another, or dispensed with altogether, until it can be mended.

Another recommendation of this article is, that one or more of the cylinders may be collapsed, or taken out from under an invalid, so as to relieve any part of the body from pressure, or to give a circulation of air.

HOSPITAL WATER BED.

This bed is made as represented in plate vii., fig. 2, by filling a box with water, and spreading over it a cloth coated with gum, which is nailed to the edge of the box.

These beds are more troublesome to fill than air beds, and, when filled, they are very heavy ; but they are without any other objection, and are much easier and more comfortable, especially for the sick and lame, than any kind of air bed.

IMPROVED WATER BEDS.

These are represented by fig. 3 in plate vii. The improvement over an ordinary water bed consists in the addition of a

mouth about twelve inches wide, sufficiently large to admit a bucket of water or a quantity of ice at once, by which means hot or cold applications can be made.

The mouth is closed by the fastening represented, plate vi., fig. . The bed represented by fig. 4, is the same as fig. 3, except it is made in different compartments like an air bed, and has also a hose attached, with a copper bulb at the end, by which the water in the bed may be heated, by placing the bulb in a furnace, or grate, at a distance from the bed, in order to impart warmth to the patient.

HOSPITAL SHEETS.

These are made of plated cloths, or vellum, about 5 feet by 6 feet in dimensions. In hospitals and sick rooms they are an almost indispensable article for the protection of beds, mattresses, &c., tending very much to the comfort of the patients, as well as their attendants.

DISSECTING GLOVES.

The sleeves and hands of dissecting gloves are made of perforated vellum, except the finger ends, which are made of drapery which is not perforated, in order that the fingers may be more completely protected, the other parts being made pervious, that they may not be uncomfortably warm for the wearer.

When attached to the dissecting apron hereafter described, or worn with it, they will be found to be useful articles, and, it may be hoped, prevent the fatal accidents that so frequently occur in the profession. The drapery, although difficult to be cut with an edged tool, is yet so delicate as scarcely to interfere with the sense of touch.

DISSECTING APRONS.

This article may be best made of gum-elastic vellum, in the form of a frock, with sleeves attached. When worn with the gloves before described, the hands will not only be protected, but the person will also be protected from the offensive effluvia of the dissecting room.

FINGER ENDS, OR COTS.

Cots are made of gum-elastic drapery and perforated drapery. They are used by fishermen and mechanics, and they are also very useful for the cure of cut and wounded fingers. When protected by them, the hands may be washed in hot or cold water with impunity.

CRUTCHES.

This article is made in two parts, in order that it may be taken to pieces and packed for travelling. The head is covered with a cushion of elastic sponge, and a spring or cushion of the same material is inserted, either in the socket between the parts, or at the end. These two cushions have the effect to make them quite easy for walking.

The wood may be covered with gum-elastic vellum, put on with glue. This covering prevents the unpleasant rattling noise commonly attending the use of crutches.

An improved and beautiful article of this kind is also made of caoutchouc whalebone, of various patterns. See plate , fig.

RUSSIAN BELTS.

These are a well-known article, made as heretofore, of various materials, with the substitution of perforated stayed compound, or knit goods for the springs, instead of the native gum webbing formerly used. See plate xviii., fig. 2.

ABDOMINAL SUPPORTERS.

These are made of different patterns, but the one which is represented plate xviii., fig. 1, has been the most generally approved, so far as the writer is informed. It is the invention of a professional gentleman.* Wherever it has been used it is spoken of in the highest terms. The only objection to it, heretofore, was a tendency to sweat the person, but since the application of perforated stayed compound, and other perforated gum-elastic goods to this use, this objection is entirely removed. There is now no question, but this and other gum-elastic supporters of a similar kind, will prove a lasting benefit to many persons. A plain piece of perforated knit goods or stayed compound, such as is sold at the shops, may also be made to answer this purpose very well.

TRUSSES.

The springs of some kinds of trusses are advantageously made either of the perforated stayed compound, or shirred goods. It is also proposed to use vellum, or plated muslin, for covering the steel or metal part of the truss, instead of morocco, buckskin, and silk, which have heretofore been used; and, at the same time, to cover the parts which require to be made soft, with elastic sponge.

* Dr. Frank Meers, of Naugatuck.

EAR TRUMPETS.

These are articles which, for many years, have been made of spiral wire hose, covered with native gum and velvet, with ivory or horn trimmings. A superior article is now made of vulcanized gum-elastic hose, trimmed with caoutchouc ivory and whalebone.

VARICOSE STOCKINGS.

This article, which has heretofore been made in Europe of the covered native gum thread, is made at much less expense, either of perforated elastic compound, or perforated knit goods.

The article is designed to be used for the bandaging of varicose veins.

NIPPLE SHIELDS.

The shield of this article is made of caoutchouc ivory or whalebone compound. The nipple of elastic compound. They are designed as a substitute for an article of this kind heretofore made of wood and metal. See plate vii., fig. 5.

BREAST PUMP.

This article is made of a hollow bulb of elastic compound, about one-quarter of an inch in thickness, and about four inches in diameter, with a glass tube inserted at the mouth of the bulb. The pump being applied to the breast, acts by the expansion of the bulb after the air has been expelled. This may be con-

sidered the simplest and most useful instrument of the kind, and one which has been generally introduced in the United States. See plate vii., fig. 6.

NURSING BOTTLES.

Nursing bottles of glass may be fitted with caoutchouc whalebone tube and elastic cork, to be cheap and useful.

POULTICING SOCKS.

These are a cheap article made of gum-elastic vellum, manufactured after the manner of water-bottles, described page . They are used for keeping poultices moist, when drawn over them on the feet or hands.

URINE BAGS.

Are made of gum-elastic compound and plated fabrics. They are made of different patterns, as represented, plate vii., by the different figures 9, 10, and 11.

The insoluble properties of these fabrics, together with their pliability, render them very suitable for this purpose.

GONORRHEA BAGS.

These are made of plated fabrics, or elastic compound, and are well adapted to the purpose for which they are made. See plate vii., fig. 12.

BED PANS.

These are intended as a substitute for the earthen or metal pans commonly used. They are made of whalebone and elastic fabrics, with a rim to be inflated with air. See plate vii., fig. 13.

PESSARY.

This article is made of a ring of non-elastic compound, or whalebone, in the same manner as hollow-ware.

SYRINGES.

Syringes are among the number of articles that were found to answer a good purpose, as made by the natives of Brazil.

Those made of vulcanized gum-elastic, after the manner of hollow ware, as represented, plate vii., figs. 14, 15, 16 and 17, are generally introduced in the United States. Like the syringes formerly manufactured by the natives, they have the recommendation of being filled by suction, from the elasticity of the gum.

BELLOWS SYRINGES.

This is a pattern of syringe, represented, plate vii., fig. 18. It is the invention of a professional gentleman of New York,* and may be considered a decided improvement, on account of the facility with which they can be operated by the patients themselves.

* Dr. Joseph Bradshaw.

SELF-ACTING SYRINGES.

Fig. 18, plate vii., represents the pattern of syringe which has for many years been made in Europe, of the MacIntosh cloths. This syringe is designed to act by the pressure of the fluid. The vulcanized fabrics are found to answer best for these as well as all other syringes, particularly on account of their resistance of the action of oils.

INVALIDS' CUSHIONS.

The different kinds of cushions described in Chapter XXVII., on Air-work, have been particularly noticed, as most comfortable for invalids when travelling; but the articles here alluded to, are cushions of various shapes, made to suit the cases of different patients.

They are mostly of the smaller sizes, and designed to relieve the patient in cases of severe illness. See plate xxvii., figs. 4, 5, and 6.

VENTILATED WATER BEDS.

These are made of strong barred vegetable leather, of the pattern, in all respects, like the ventilated air bed, represented, plate , fig. , except that the opening for filling them is made large, like those of the other water beds, represented, plate , fig. .

STETHESCOPES.

These are made of artificial ivory.

HOT-WATER BOTTLES.

See Chapter , and plate xxx.

CHAPTER XIII.

PHILOSOPHICAL, OPTICAL, AND MATHEMATICAL INSTRUMENTS.

Thermometer frames and scales. Telescopes. Gas bags. Gasometers. Hydrostatic bellows. Opera glass cases. Quadrants. Barometers and chronometers. Water levels. Squares and bevels, curves, triangles, and parallel rules. Reel measures. Leveling rods. Dry measures. Wine measures. Scales and rules. Instrument cases. Instrument handles.

There are a variety of instruments and appliances under this head, for which the caoutchouc fabrics and compounds are found useful; among them the following may be noticed.

THERMOMETER FRAMES AND SCALES.

Thermometer frames are manufactured of caoutchouc whalebone. This material is suitable for this purpose, because it is not warped or cracked by heat or cold like wood, or corroded like metal. They may be immersed in boiling liquids or steam without being injured.

TELESCOPES.

The cases of telescopes, opera spy-glasses, and other optical instruments, may be made with advantage of caoutchouc whalebone or ivory, or being made of sheet metal, they may be improved by being enameled with caoutchouc enamel.

GAS BAGS.

These are among the articles first made of the McIntosh fabrics, and which were commonly found to answer a good purpose. They are now more cheaply manufactured, and answer better when made of vulcanized gum-elastic plated fabrics or elastic compound.

They are made small for the laboratory, or of extra large sizes for the conveyance of gas from one place to another.

The value of the fabrics for this purpose is becoming well known to chemists and others.

GASOMETERS.

A tank or reservoir is made of caoutchouc plated canvas for holding gas in boats and buildings, where it is made on the premises. They are made of the same form as a tub or bellows, with a top of whalebone board, upon which weights may be placed when required, or they are constructed like self-inflating air-work. See plate , figs.

HYDROSTATIC BELLOWS.

The sides of these bellows are made of plated India rubber canvas, in the common form, as represented plate , fig. , or that of self-inflating air-work, which is preferable, as in fig. . The tops and bottoms are made of caoutchouc whalebone board, to which the flexible parts or bellows of the instrument are cemented; consequently, nails are dispensed with in the manufacture, while the seams are quite tight and strong, and altogether the article is very superior to those which were formerly made of other materials.

OPERA GLASS CASES.

Caoutchouc ivory is a suitable material for the cases of opera glasses, because of its lightness, and not being affected by change of temperature. See plate , figs.

QUADRANTS.

Those parts of the frames of quadrants which have heretofore been made of wood, may be made stronger and less liable to warp and crack, from caoutchouc ivory and whalebone. See plate , figs.

BAROMETERS AND CHRONOMETERS.

The cases of barometers and chronometers may be advantageously moulded from caoutchouc whalebone. The cases of clocks and time-pieces are also made of the same materials, in the same way; or when made of wood, they are veneered with caoutchouc veneer. An improvement is also made in these cases by packing them with gum-elastic sponge, so as to make them quite water and air-tight, thereby excluding dust and dampness. See plate , fig.

WATER LEVELS.

Caoutchouc ivory and whalebone are materials suitable for water or spirit levels, on account of their solidity, and not being liable to warp or crack.

SQUARES AND BEVELS, CURVES, TRIANGLES, AND PARALLEL RULES.

Caoutchouc whalebone is equally well adapted for these articles, as all of them require tough, hard, and durable materials. As they are all of them made in the same way in moulds, or between plates of metal, they are described under one head.

REEL MEASURES.

The cases of carpenter's reel measures are made of caoutchouc whalebone. The measure, or tape, is made of gum-elastic vellum, or of linen tape coated with gum-elastic compound. The whole making an improved tape measure. See plate , figs.

LEVELING RODS

The large dimensions, and the use which is made of leveling rods, require that they should be made of a material less liable to spring or warp than any wood of which they have heretofore been made. When moulded of caoutchouc, they may be made hollow and light without being liable to either of these objections. Like scales and rules, they are graduated in moulds when vulcanized.

DRY MEASURES.

Dry measures are made of caoutchouc whalebone and whalebone board. When formed of these materials, they are strong, light, and durable. See plate , figs.

WINE MEASURES.

These articles are manufactured of caoutchouc whalebone. They are moulded of this material in one entire piece.

They are much lighter than metal; they are preferable to tin or copper, because they do not rust or corrode, and owing to their elasticity, they are not, like tin or metal, liable to be indented. See plate , figs.

SCALES AND RULES.

Mathematical scales and carpenter's rules are manufactured of caoutchouc whalebone and ivory, as substitutes for boxwood and ivory. Although they are not yet made as white as ivory, they are preferable to either boxwood or ivory on other accounts. They are stronger and not so liable to warp or crack as ivory or boxwood. They are manufactured with much greater economy in the saving of labor and material. The mountings are securely set in while they are being vulcanized in the mould. They are also graduated by the mould during the same process. By which process the cost of manufacture is very trifling compared with that of other rules, as heretofore.

INSTRUMENT CASES.

These are made of caoutchouc whalebone. The two parts moulded, each of them, in one entire piece.

They are further improved by a hinge of gum-elastic compound, and a cushion or packing of gum-elastic fabric around the edge, which makes them quite air-tight, so that the instruments contained in them are prevented from rusting. See plate , fig.

INSTRUMENT HANDLES.

Superior handles are manufactured from caoutchouc ivory and whalebone, for various kinds of surgical, dental, etching, drawing, and engraving instruments. The shanks of the instruments being made rough, the handles are formed on them, and shaped in moulds when vulcanized, whereby there is great economy in the manufacture; and a decided improvement is made in the tools by the handles being secured so perfectly that they cannot come off, or be taken off without destroying them. See plate , figs.

CHAPTER XIV.

MUSICAL.

Fife. Flute. Clarionet. Clarionet reeds. Piano-fortes. Instrument key stops. Organs Accordions. Bag-pipes. Music boxes. Bass viols and violins. Drums.

Soon after the invention of caoutchouc or gum-elastic ivory, it was supposed that it would probably answer well for some kinds of musical instruments, before any experiments had been made to ascertain how far it might be used for such purposes. Since that time it has been proved that this material may be applied to a much greater variety of them than was even supposed, and that, including the other compounds and fabrics, some one or more of them may be used either for the whole or for parts of almost every musical instrument.

The advantages claimed for these substances for this use, will be alluded to in the description of some of the articles hereafter specified, as the different substances have their peculiar advantages for particular instruments. There is great economy in the manufacture of nearly all of them. They may be moulded into perfect forms, with a perfect finish, as easily as wax or lead could be made into the same shapes, and the farther facility with which they are vulcanized by a new method, described Vol. I., page , renders it certain that this new use of caoutchouc or gum-elastic, will become one of the most extensive.

Another superiority claimed for these instruments is that, owing to their uniform quality (unlike those of wood) and to their

uniformity of shape, the cheapest kinds of them may be equal to the most costly, so far as tone is concerned, which will bring within the reach of all classes, instruments equally good. Among those which have been made are the following.

FIFE.

Gum-elastic ivory was first applied to this instrument as being the most simple in its construction. The experiment was entirely successful.

FLUTE.

For this instrument caoutchouc or gum-elastic ivory has properties peculiarly adapted. Being impervious to moisture, it is not, like ivory or wood, liable to split, and for tone it far surpasses either of those materials.

CLARIONET.

The gum-elastic ivory is also adapted to clarionets, the tone of which it improves even more than that of the flute.

CLARIONET REEDS.

India rubber whalebone has the qualities suitable for the reeds of clarionets and other wind instruments—toughness and elasticity.

PIANO-FORTES.

It is yet a subject of inquiry, to what extent caoutchouc may be applied to the construction of piano-fortes ; but it is confidently expected that caoutchouc veneers will be substituted in their manufacture for wood veneers, on account of their cheapness and durability, their not being liable to warp, as well as their susceptibility of receiving a variety of ornamental styles of finish, more beautiful than wood. The ivory compound is suitable for the black keys.

As early as 1845 or '46 the writer applied the vulcanized gum-elastic to piano-forte hammers. The experiment did not then result in any improvement. Since that time, the various fabrics having been made of every grade of texture, from the softest kid to that of ivory, and these various textures being made susceptible of combination in different layers, it is presumed that this application will eventually become quite successful.

INSTRUMENT KEY STOPS.

The water-proof quality and softness of the gum-elastic sponge fabric, and also of the elastic compounds, render these fabrics well adapted for key stops for musical instruments.

They are most completely made in moulds, with the inside of sponge and the outside of elastic compound, the back being napped with fibre for cementing to the key.

ORGANS.

The extent of the application of caoutchouc to the construction of organs, is, as in the case of some other instruments, in some degree a matter of conjecture. There is, however, little doubt but that the pipes may be advantageously made of caoutchouc whalebone or ivory. The bellows also may be made of plated canvas, which will no doubt answer this purpose better than leather.

ACCORDIONS.

India rubber whalebone and ivory are unquestionably superior substances for those parts of accordions which have heretofore been made of wood, because of the facility with which they are moulded, and their being not liable to warp. The light gum-elastic fabrics, tissue and vellum, are also suitable for the bellows on account of their pliability, durability, and air-proof qualities.

BAG-PIPES.

The pipes of the bag-pipe may be made of caoutchouc ivory, the bags of plated fabrics or vegetable leather.

MUSIC BOXES.

Caoutchouc ivory is well adapted to the manufacture of the cases of music boxes, because of its elasticity, its durable properties, and the facility with which it is moulded and ornamented.

BASS VIOLS AND VIOLINS.

Some experiments have been made with these instruments, from which ultimate success in the manufacture of them from caoutchouc may be reasonably anticipated.

DRUMS.

India rubber whalebone board and whalebone are suitable materials for drums. The flexible fabrics, plated canvas, or vellum, are suitable for drum heads, because they are not injured by dampness. The elastic knit fabrics are also well adapted for the heads and covering the sticks of the bass drum.

CHAPTER XV.

GYMNASTICS AND CALISTHENICS.

Gymnastic ropes. Jump ropes. Inflated bat-club. Chest expanders. Baby jumpers. Swings. Invalids' jumper.

GYMNASTIC ROPES

Are manufactured from elastic cordage. There is no advantage claimed for these over common ropes, unless it is their elasticity and giving variety to articles constructed of them. See plate xv., fig. 1.

JUMP ROPES

Are manufactured from elastic cordage. It is no better for this purpose than common rope, except that it may serve to please better as a toy, and afford additional gymnastic exercise and amusement, on account of its elasticity.

INFLATED BAT-CLUB.

This article is made of vellum or felt, and is inflated by a self-acting valve tube at the end. They form a weapon, the hardest blows from which are quite harmless. See plate xv., fig. 2.

CHEST EXPANDERS.

This is a strap of shirred goods, or elastic compound, used for exercising the arms and chest, with a handle attached to each end. See plate xv., fig. 3.

BABY JUMPERS,

Or what are sometimes called the infant's gymnasium, will be understood by the diagrams in the plate, so that they may be constructed in a cheap way by those who cannot afford to purchase a completely manufactured article.

Fig. 4 is the cheapest and really most convenient arrangement, consisting of a straight bar of wood or bamboo, or a tin tube, which should be cushioned and covered; this is a substitute for the hoops that are used in fig. 2. The springs of elastic cordage or stayed compound used for this purpose, are about eighteen inches long, one inch wide, and one-quarter of an inch in thickness. Figs. 5 and 6 represents two kinds of harness or dress, into which the child is placed, before it is suspended by the straps to the hoops or bars.

In fig. 4 the straps are united, and hung over the bars at the ends, by which the child is so balanced that there is not the slightest danger of its getting loose; a small notch or bead being formed at the ends of the bar to prevent the strap slipping off. In figs. 7 and 8, the straps are buttoned to hoops. A basket of light willow, fig. 9, is commonly first used for the infant, which answers a much better purpose than the rocking cradle, giving the tossing motion with which children are so well pleased. At the age of about five months, the infant is old enough to be put into the jumper, with which they almost uniformly continue to be delighted from the first time they are placed in it, until they can walk, when they prefer a wider range. Should they, as sometimes happens, acquire a habit of whirling around, a string

attached to a bed-post, a nail, or some part of the room, will prevent them.

The spring was first applied to this purpose by the factory operatives at Naugatuck, when the apparatus was made in a rude way, after the plan of fig. 4. The springs were next put in market for sale The fanciful arrangement of the hoop was invented and patented by a gentleman in New York.*

The springs may be obtained at the shops, at a low price, and trimmed by any person according to their own taste and means.

Care should be taken when the child is suspended from a hook in the wall, that it is strongly fastened, as the consequences of neglect to do this have sometimes proved serious.

SWINGS.

The seats of these swings are covered with gum-elastic vellum, vegetable leather, or cushioned with gum-elastic sponge fabric, so as not to be injured by exposure to the weather.

A spring of elastic cordage is inserted in the strap or rope, in the manner represented in the plate, figs. 10 and 11, which gives a perpendicular, as well as a backward and forward motion to the swing.

INVALIDS' JUMPER.

This is made on much the same plan as the springs above described, except that a chair is used instead of a seat, as represented in the plate, figs. 12 and 13, with hand straps attached.

* Mr. George Tuttle

CHAPTER XVI.

TOYS AND TRIFLES.

Dolls. Magnetic toys. Quadrupeds and birds. Air hoops. Rattle-boxes. Cross-bows. Toy guns. Teething rings. Battle-door. Picture books. Kites. Whistles. Needle cases. Watch guards. Shawl pins. Hair clasps. Bat and parlor balls. Hair loop. Churches and cottages. Vehicles. Boats. Hard compound toys.

A VARIETY of toys are made already of the different gum-elastic fabrics, and it is very evident that the list of them may be extended almost indefinitely. A few of them only are described in this work.

The tissue is well adapted for kites; the hollow ware for rattle-boxes, dolls, balls, &c., as well as for the magnetic toys, such as fishes, ducks, quadrupeds, &c.; the drapery for some ornamental articles, imitation grapes, &c. Of the importance of these improvements in the extension of the manufacture of toys, the writer has nothing to say, but much might be said as relates to economy in such as are made. It will be admitted most certainly, that vast sums of money may be saved in the aggregate, by the manufacture of toys from materials that will cause them to last for years instead of a passing hour. It may be remarked that gum-elastic toys, as regards form, finish, &c., are, in general, or may be much more true to nature, uniform, and complete than other toys commonly are; and that where oil colors are put upon the surface of the toys, when they become defaced or soiled, as they generally will be before the article receives the slightest injury in any other way, the coloring may all be removed by boiling in soap suds, and the toy be left white, or recolored if desired.

If the good maxim is applicable to toys, as to other

things, that every thing which is worth doing is worth doing well; and more than all, if the durability of these things is of any sort of consequence, the value of gum-elastic for these branches of manufacture is greater than would at first appear; and it is not strange that it should have been one of the first attended to by the Indians, in the construction upon clay forms of such rude images as they conceived to be quadrupeds and birds, and which were sold in civilized countries to considerable extent for toys.

It may be submitted to the investigations of the phrenologist, to ascertain what effect the durability of gum-elastic toys may have upon the organ of destructiveness in children; certain it is, however much they may exercise it, it will not be easy for them to destroy or mutilate these toys.

DOLLS.

This is, perhaps, the most important of all the articles in the toy line, at least the one which is the most in demand.

This article is made after the method of hollow ware, either of elastic compound or of gum-elastic ivory. It cannot be injured by the ordinary play of children without the aid of fire, violence, or very destructive edge tools.

On the manufacture of the first specimen, the license for this article for the United States, was disposed of by the writer to an enterprising merchant of New York.*

MAGNETIC TOYS.

Fishes, ducks, tortoises, &c. are made of elastic compound or gum-elastic ivory, after the method of hollow ware. They are magnetized in the same way as the metal toys have hereto-

* B. F. Lee.

fore been, by the insertion of a steel point at the nose or bill. For the information of those who have not seen these toys, it may be said, that when placed in the water, they will sail or swim after a magnet when one pole of it is placed before them, or go from it when approached with the other pole of the magnet. See plate vi., fig. 1.

QUADRUPEDS AND BIRDS.

These are also made in moulds like hollow ware, and may be so constructed as to make different sounds, without being so liable as other toys to get out of repair in this particular.

AIR HOOPS.

Hoops of all sizes may be made of elastic compound, and inflated with the self-acting valve tube. See plate vi., fig. 2.

Solid hoops may also be very completely made of gum-elastic whalebone.

RATTLE BOXES

Are made of elastic compound, with the handle of the same material, and a teething ring of elastic compound attached to it. Being quite soft to the mouth, they make a suitable toy for young children. The sound of these boxes is very good, being produced by small metal bells within the box. See plate vi., fig. 3.

CROSS-BOWS.

Gum-elastic springs are used for cross-bows, as represented in plate vi., fig. 4. The advantage of this spring over the bow is, that it does not occupy much space like the bow.

TOY GUNS.

These may be made in a variety of ways, with an elastic spring like the cross-bow described. The only objection to these guns is, that they require care, to prevent their becoming a deadly weapon.

TEETHING RINGS.

This is one of the first toys made of the native gum-elastic in France and England, many years previous to their being made in America, of vulcanized gum-elastic.

BATTLE-DOOR.

The cork for this toy is made of gum-elastic sponge and feathers, and the bat of a hoop, of gum-elastic whalebone, covered with gum-elastic vellum or parchment.

PICTURE BOOKS.

May be made of elastic tissue to advantage, if durability is at all desirable in such an article.

KITES.

The frame of all kinds of kites may be covered with tissue to much advantage, not only because it is more durable than paper, but because it is water-proof, and may be *kited* in a storm.

Kites are also made of this fabric inflated with air around the border, which are inflated by the self-acting valve tube. See plate vi., fig. 8.

WHISTLES.

These may be noticed, as being made of non-elastic compound and gum-elastic ivory, on account of their being a common toy, and forming an appendage of the child's teething ring. Whoever purchases the article at a fair profit upon the cost of production, will not have occasion to complain of having paid too "dear for the whistle." The invention of a lady.

NEEDLE CASES.

A case for securing knitting needles is very completely made of gum-elastic ivory, in connection with a spring of gum-elastic braided cord. See plate vi., fig. 5.

This article was first made in Europe, of metal, with a spring of the native gum.

WATCH GUARDS.

These are well known to the public generally, as among the convenient and useful articles formerly made of braided cord from native gum-elastic, now made of vulcanized cord.

When made of vulcanized cord, they do not soften or decompose like those made of the native gum.

SHAWL PINS.

A useful little article made with a cap, to cover the point of the pin, and attached to it by a spring of gum-elastic braided cord. See plate vi., fig. 6.

HAIR CLASP.

This is an ingenious little article,* made of gum-elastic, with a clasp of polished steel, or other metal, and used by ladies as a hair tie. There is also a tape made of gum-elastic, which is used for the same purpose, alluded to, Chapter XIV. See plate , fig. .

BAT AND PARLOR BALLS.

See Chapter

HAIR LOOP.

This consists of an elastic ring or tie, looped upon an artificial ivory button. It is found useful for fastening ladies' hair. See plate vi., fig. .

* Invented by a gentleman of Worcester, Mass.

CHURCHES AND COTTAGES.

A variety of these and other toy buildings are made of gum-elastic compound, in moulds, like other toys.

VEHICLES.

For this class of toys the gum-elastic compounds have two special recommendations. They are much more durable than wooden vehicles, and do not make a rattling noise, like those of tin.

BOATS.

These fabrics, both the elastic compound and whalebone, are exactly suited to the manufacture of toy boats, on account of their strength and water-proof quality.

HARD COMPOUND TOYS.

All the toys that have been described, and an almost endless variety of others not noticed, may be made of the hard compounds—caoutchouc enamel, ivory and whalebone—with advantage.

CHAPTER XVII.

SPORTS AND GAMES.

Footballs. Parlor balls. Bat and wicket balls. Boxing gloves. Boxing jackets. Ten-pins. Billiard cushions. Billiard balls. Improved skates. Skate trimmings. Skating caps. Skating jackets. Backgammon boards.

FOOTBALLS

Are either made of elastic compound, in the same way as hollow-ware, or they may be more substantially made of gum-elastic felt, or vegetable leather.

These are uniformly inflated with a tube, as they are not otherwise made stiff enough to retain their shape without being too heavy.

In case these balls become damaged, they may be used instead of leather cases for bladders, although when properly manufactured, it will be found an exceedingly difficult matter to injure them fairly.

PARLOR BALLS.

Parlor balls are manufactured from tissue or vellum, and are inflated by the self-acting valve tube, described, page .

A curious article of this kind is also made from drapery, stayed by being netted with elastic cord. See plate xxiii. fig. 1.

BAT AND WICKET BALLS

Are made of elastic compound, by the method of manufacturing hollow-ware, described, page , Vol. I. When made of a suitable thickness, they will not collapse when damaged, but will retain their shape from their elasticity. They are sometimes perforated in the manufacture like sleigh bells, to admit the sound of small bells or pieces of metal that are inclosed within them when they are made.

All the varieties of gum-elastic balls admit of various styles of ornamenting, embossing, &c.

BOXING GLOVES.

The boxing gloves heretofore manufactured of buck-skin, may be improved by attaching an air chamber upon the back of the glove, instead of one that is stuffed; or the whole glove may be made of gum-elastic fabrics, making use of the perforated fabrics for the glove. In either case the article is inflated with the self-acting valve tube. See plate xxiii., fig. 2.

BOXING JACKETS.

This article is made of ventilated air-work of gum-elastic knit fabrics. When inflated with air, the hardest blow has very little effect upon the person wearing it. See plate xxiii., fig. 3.

TEN-PINS.

These are wooden pins of the common kind, first covered with vellum cloth, and next wound with vellum cord, like cord ware. They are also made either of gum-elastic sponge or elastic

compound, in moulds, in the same manner as bat balls. They may be weighted with fluids or metals, so as to stand more or less firmly, and to be more or less liable to be scattered by the ball.

BILLIARD CUSHIONS.

The native gum has formerly been used for this purpose with some success.

A decided improvement has been made in this article by a billiard-table manufacturer in New York,* by the use of tubes made of vulcanized gum, and ropes made of gum-elastic sponge. These cushions or ropes of gum-elastic sponge are joined to the rim of the table, and are considered a great improvement upon billiard tables.

BILLIARD BALLS.

It is supposed that caoutchouc ivory may answer better for billiard balls than real ivory, for the reason that there is not the same difference in the weight of its parts that there is in real ivory, and because the material is cheaper, is worked without waste, and can be made of any desirable degree of hardness.

IMPROVED SKATES.

A description of this article is given, because it is believed it will form a valuable improvement in skates, and for the reason that it illustrates forcibly, as in the article of Military Caps, the advantages which are derived from welding the hard and non-elastic vulcanized fabrics, to the flexible and elastic ones.

* Mr. Abraham Bassford.

These skates are formed in moulds like gum-elastic hollow-ware. The steel runner is inserted in the bed, (which is made of caoutchouc ivory,) when the ivory is in a soft state.

The upper part, or shoe, is made of perforated elastic compound, and cemented to the caoutchouc ivory When straps are required, they are also cemented to the ivory; the entire skate is then vulcanized in the mould at one time. The design of the elastic shoe and straps is to obviate the difficulty of the skate getting loose, and the feet being hurt, as is the case with skates fastened in the usual way with leather. See plate xxiii., fig. 7.

SKATE TRIMMINGS.

Skates may be more firmly bound to the feet, and rendered more comfortable, by inserting a spring of elastic compound near the buckle in the front straps, and the addition of a heel-strap made of perforated elastic fabrics. See plate xxiii., fig. 4.

SKATING CAPS

Are manufactured of porous napped fabrics, with a belt about four inches in width and two in thickness, made of the quilted fabrics, or of air-work, and inflated with air. See plate xxiii., fig. 5. Considering the numerous hurts received by boys falling upon the ice, this will not be considered an unnecessary precaution. The same article, when made of tissue, of suitable patterns, might also be found useful for children, to protect them from injury by falls.

SKATING JACKETS.

This article is manufactured of vellum, and is either quilted or inflated with air. It is not only designed for a life-preserver

where there is danger in skating, but is intended as a protection from harm by falling. It is made open in order to make it cool, being a sort of inflated net-work. With one of these jackets, and a cap such as is described above, lads may be safely equipped for skating. See plate xxiii., fig. 6.

BACKGAMMON BOARDS.

Gum-elastic vellum, printed or colored for the purpose, is a suitable article for covering backgammon and checker boards, on account of its durability and softness. A more highly finished and beautiful article may also be made of caoutchouc ivory, the figures and colors being inlaid while the gum is in a soft state, in the process of manufacture.

CHAPTER XVIII.

SPORTING.

Gun cases. Game bags. Fishing rods. Fish bags. Fish baskets. Self-filling bottles. Sportsmen's flasks. Sportsmen's canteens and fishermen's bottles. Sportsmen's portable cups. Shot-bags. Powder flasks. Pouches. Sportsmen's pantaloons. Sportsmen's boots. Sportsmen's boats.

A VERY considerable number of articles for the use of sportsmen have been made of vulcanized gum-elastic materials, and found to answer so well, that the demand for them is constantly increasing. Among numerous articles of this kind, those here described are thought to be particularly deserving of notice.

GUN CASES.

Gun cases are manufactured of non-elastic compound or vegetable leather, after the method of gum-elastic hollow-ware, and are designed as a substitute for those heretofore made of sole leather.

When the breech is made tight, in the same manner as the gun-covers described in this work, they will, like them, not only buoy up the gun in the water, and protect it from wet, but also answer in part the purposes of a life-preserver. See plate xxii., fig. 1.

GAME BAGS.

To prevent these bags from being uncomfortably warm for the sportsman, they are made of perforated gum-elastic plated

vellum, with water-proof pockets attached, made of the same material, not perforated, in which articles may be kept dry.

The netting of this article is made of elastic cord. See plate xxii., fig. 2.

FISHING RODS.

Fishing rods which are made hollow, and in sections to fit one within the other, so that they are portable, like the cane rods, may be very completely manufactured from caoutchouc whalebone.

FISH BAGS.

Like game bags, these are made of gum-elastic vulcanized fabrics, in two apartments, one of which is water-proof, for containing articles that need to be kept dry.

The other apartment is made of perforated goods, so that it may be taken off upon occasion, and fish may be kept alive in the water, or be carried alive in the water-proof apartment, containing water.

Separate small apartments are also added, for the purpose of containing bait, tackle, &c. See plate xxii., fig. 3.

FISH BASKETS.

This article, which has heretofore been made of willow, may be advantageously made either of cord-ware or perforated gum-elastic whalebone board. See plate xxii., fig. 4.

SELF-FILLING BOTTLES.

These are made oval-shaped, of elastic compound, of various sizes, after the manner of hollow-ware, the mouth being made of caoutchouc ivory. The improvement in these articles consists in this, that after being collapsed by the pressure of the hand, they will fill themselves without a tunnel, and will also take the water quite pure from a spring or rivulet which is very shallow, when it could not readily be obtained clear in any other way. This bottle is especially valuable to sportsmen and farmers. When it is collapsed, and the cork is inserted, it occupies but little space. See plate xxii., fig. 5.

SPORTSMEN'S FLASKS.

This is a glass bottle, covered in the same way as the bottles and demijohns described in another chapter, or they are made of caoutchouc ivory without glass. They are made in a variety of patterns, such as are commonly made of leather, in two parts; the cover or bottom which comes off, answering the purpose of a drinking cup. See plate xxii., fig. 6.

SPORTSMEN'S CANTEEN AND FISHERMEN'S BOTTLE.

These articles are made with the improved caoutchouc ivory hose-stopper, (represented, plate , fig. ,) through which one can drink from them without drawing a cork, and by which they may also be inflated and used as life-preservers, when emptied of water; for these reasons, these canteens are believed to be one of the most useful and important improvements in gum-elastic. See plate xxii., fig. 7.

SPORTSMAN'S PORTABLE CUP.

These articles are made of elastic compound or vegetable leather. They are intended as a substitute for the articles heretofore made of animal leather, well known to sportsmen. The chief recommendation of this pattern of cup is, that it folds more compactly than any other.

SHOT BAGS.

Shot bags are manufactured, either single or double, of non-elastic compound or vegetable leather. They may be advantageously made in moulds, like gum-elastic hollow-ware, with caoutchouc ivory tubes, cemented to the bag in the process of manufacture.

POWDER FLASKS.

Sportsmen's flasks, for either powder or shot, are made of non-elastic compound or gum-elastic whalebone, by the same method as gum-elastic hollow-ware. They may be recommended for their durability as well as for their water-proof qualities. See plate xxii., figs. 8 and 9.

POUCHES.

A variety of patterns of these are made of gum-elastic fabrics. With the addition of the water-proof clasps or fastenings, they are made quite water-proof. See plate xxii., fig. 10.

SPORTSMEN'S PANTALOONS

Are made like sporting boots, with the addition of waistbands of plated cloth or corded vellum. They are only suitable for wading, fishing, or standing in the water, on account of their too great warmth.

SPORTSMEN'S BOOTS.

See Chapter XX.

SPORTSMEN'S BOATS.

See Chapter

CHAPTER XIX.

HORSE TRAPPINGS.

Saddles. Saddle covers. Martingal. Girths. Surcingles. Stall carpets. Riding bridles. Halters. Fly-nets. Fetters. Foot-caulking. Horse-blankets. Improved horse-blankets. Improved stirrup. Whips. Buffalo and imitation buffalo robes. Feed-bags. Hoof-shoes. Knee-fenders. Fetlock fenders.

The ills to which the horse is subject from his very nature, in addition to his servitude, are every way deserving of consideration; and any thing that can be done for his relief, or to render his condition more comfortable, seems almost as much to be desired as if done for man himself; his sufferings demand sympathy, and man's feelings should be enlisted in his behalf, not only on the score of mercy, but also of interest. Most of the appliances of gum-elastic that are intended for the comfort of the horse, appear to be without objection. In no part of his harness is there such defect as in the collar and saddle. This defect arises mostly from the unsuitableness of the material of which they are made; and as yet, so far as has been known, no other would answer the purpose at all. It would seem that the sufferings of horses from galling collars and saddles, had ceased to be regarded, from despair of finding a remedy. The galling of the horse by the leather collar is the most obvious, but not the most injurious of its effects. It is very frequently put on cold and wet, and often frozen, and unquestionably more colds are taken by horses from this unnoticed cause than almost any other. Whether these evils are to be remedied by the inventions described in this and the following chapter, remains to be proved.

SADDLES.

Specimens of saddles have heretofore been made of gum-elastic in different ways, some inflated with air, others with elastic compound springs.

Notwithstanding there are conflicting opinions about the usefulness of springs of any kind as applied to saddles, it is believed that the manufacture of gum-elastic saddles, with springs of the same material, and also of air, will become an important one. The objection to leather saddles, that they are liable to become saturated with water, is one that is well known to all that are accustomed to horseback riding.

By exposure to the weather and storms, the saddle is not only soon destroyed, but the health and the life of the rider are much endangered. To remedy these evils is an object worthy the attention of the philanthropist, as well as the manufacturer. It is probable that vulcanized gum-elastic is suitable for this purpose, and since the introduction into this manufacture of gum-elastic sponge, and the porous fabrics and hard compounds, it is reasonable to suppose that these materials may be so combined as to form a saddle comfortable for the horse and the rider. The inventor has made some specimens, both of the common forms and those that are inflated with air, according to his idea of the best combination of these materials for this purpose. See plate xxiv., figs. 1 and 2.

SADDLE COVERS.

Saddle covers are made of gum-elastic plated fabrics. They are designed for the protection of leather saddles and the comfort of the horseman. They may also be made in moulds of gum-elastic sponge. See plate xxiv. fig. 3.

MARTINGAL.

The rings of the gum-elastic martingal are manufactured of caoutchouc ivory. The straps are corded harness leather. An improvement is made in the straps by inserting in them a spring of elastic compound. See plate xxiv., fig. 4.

GIRTHS.

Saddle girths are made of gum-elastic or other webbing, with a spring of perforated elastic compound, about two inches in length, inserted either about the middle or at either end of the girth. The springs are varied in length, according to the thickness of the compound, and the width of the web. By the use of this girth the saddle is made more secure from turning, as the girth may be drawn very tight without inconvenience to the horse.

It is believed that a perforated gum-elastic felt or vegetable leather webbing will be found to make an additional improvement in the girths here described, on account of its durability and cleanliness. When this webbing is used, it is necessary that they should be made up at the factories, for the purpose of staying the buckle holes, in the same manner as the traces and baggage straps hereafter described. See plate xxiv., fig. 5.

SURCINGLES

Are made either of woven web or of perforated felt, like the saddle-girths already described, with a spring of the same sort, only about twice the length of that in the saddle-girths, so as to

give greater elasticity. In addition to cleanliness, another advantage in the use of this surcingle is, that with it the horse's blanket can be kept on at night, which it is extremely difficult to do with a non-elastic surcingle. See plate xxiv., fig. 6.

STALL CARPETS

Are made of perforated sponge or thick packing.* Gentlemen who are careful of their horses will hardly regard the expense of this article. The entire cleanliness of a stall carpeted in this way is a great consideration, particularly if it be true, as has been stated, that blindness of horses is often in consequence of the vapor of ammonia arising from wet stalls. The comfort and health of horses may be greatly promoted by the use of these carpets. When made of a suitable thickness, this article forms not only a carpet, but also a bed for the horse. See plate xxiv., fig. 7.

RIDING BRIDLES.

The bits and buckles of these riding bridles are covered with caoutchouc enamel, the check rein is made in part of elastic compound.

The hand reins are made of corded caoutchouc leather, covered with a light woven fabric.

HALTERS.

Halters of different kinds may be cheaply and substantially made at the gum-elastic factories, of corded caoutchouc harness leather.

FLY NETS

Are made of elastic cord, spun or cut from the elastic compound. The webbings or stays which connect the netting, are made of knit goods or gum-elastic felt. The advantages claimed for this article are, that they will not soil or rot like those made of cotton or worsted, and that when soiled they can be readily cleansed by rinsing in water.

FETTERS.

The fetlock rings of these are made in moulds, of gum-elastic sponge. They are either made whole and slipped over the horse's hoof, or they are made open and secured around with buckle and straps. Instead of a chain, elastic cordage is used for connecting them. If any recommendation can be given in favor of fetters of any kind, these may be considered comparatively comfortable for animals. See plate xxiv., figs. 8 and 9.

FOOT CAULKING.

A heavy sheet of elastic compound or packing is sometimes used with very great advantage, when the frog and lower part of the horse's hoof has been wounded or injured.

It is nailed between the shoe and the bottom of the foot, so as to protect the frog from injury in travelling when it is inflamed.

HORSE-BLANKETS.

One of the earliest applications of gum-elastic was to horse-blankets, which have become well known to the public. They

are most useful when horses are standing exposed in cold storms. At other times they are objectionable on account of confining perspiration. Cloths plated on both sides are most suitable for this purpose, for the reason that cloths, coated on both sides, are not so liable to become mildewed, and to rot, as those which are coated only upon one side.

IMPROVED HORSE-BLANKETS.

An improved article of horse-blankets may be made of plated and napped fabrics, in two ways. Either by ventilating them in the way described and represented in plate , fig. , or by making the top of the blanket of the above materials finely perforated, as represented by plate , fig. . Either of these blankets will permit the free escape of perspiration from the horse, and yet exclude the rain.

IMPROVED STIRRUP.

Stirrup irons of all sorts may be protected from rust by covering them with caoutchouc enamel. A further improvement is made in them which is particularly applicable to ladies' stirrups, by the addition of a cushion of gum-elastic sponge to the bottom of the stirrup. See plate , fig. . A limited spring of stayed elastic fabric, of about two inches in length, is inserted in the stirrup leather, which gives a pleasant elasticity to the strap. See plate xxiv., fig. 12.

WHIPS.

Team whips, or an article made as a substitute for the covered leather whips, have been manufactured by the licensees* from

* Newark India Rubber Company.

these materials, which have been much approved on account of their durability, and not being liable to be damaged by wet like leather. There is good reason to suppose that when the manufacture is farther advanced, a great variety of fancy whips, as well as whip-lashes, will be made with equal advantage and economy. The artificial gum-elastic ivory is certainly a very suitable article for the mountings of such articles.

BUFFALO, AND IMITATION BUFFALO-ROBES.

Buffalò robes are much improved and protected from wet by being covered on the flesh side of the skin with a lining of napped fabric. A good substitute for the buffalo-robe is also made by lining a heavy woolen drugget with napped caoutchouc cloth, or plating the drugget with gum-elastic.

FEED-BAGS,

Which are used by teamsters for feeding horses, are manufactured of plated fabrics, or perforated vegetable leather. When made of the former material, they may also be used for watering the horse; and when made of the perforated fabric, they may be recommended in preference to those made of close-woven canvas, on account of the free admission of air to the horse while feeding.

HOOF-SHOES.

These are made of vegetable leather, or of non-elastic compound, in moulds, after the method of gum-elastic hollow-ware. They are a useful and convenient article for protecting the feet

of lame horses while standing in the stall; and are preferable to leather on account of their water-proof quality, especially when poultices are applied. See plate xxv., fig. 1.

KNEE FENDERS.

Horses' knee fenders or bandages are made very complete of perforated gum-elastic felt, or stayed elastic compound. Bandages of these materials, both with and without perforating, are useful for fomentations in case of hurts, and to relieve sprains. See plate xxv., figs. 2 and 3.

FETLOCK FENDERS.

These are made of perforated caoutchouc fabrics, elastic compound, or elastic sponge, as represented plate xxv., fig. 4. They are also made in moulds, of a ring of elastic sponge, as represented, fig. 5. This ring, being sufficiently elastic for the purpose, does not require a buckle and strap, but is drawn on over the hoof.

Either of these articles will be found a desirable substitute for those made of leather, which have formerly been in use.

CHAPTER XX.

HARNESS.

Horse collars. Harness saddles. Harness bridles. Covered buckles. Baggage straps. Elastic straps. Collar pads. Traces. Reins.

The writer first attempted to manufacture gum-elastic harness from coated canvas, in 1843, for which, together with buckles and other gum-elastic articles, a gold medal was awarded at the fair of the American Institute, in 1844. Subsequently, much difficulty was met with in the attempts to manufacture harness, in consequence of the want of a canvas strong enough for the purpose, and the buckle holes tearing out. These obstacles being now removed by the inventions hereafter described in this work, it is rendered certain that some parts, at least, if not the whole harness, can be made of gum-elastic fabrics with economy and advantage. As different parts of the harness are made of different materials, with advantages peculiar to each, they are, therefore, separately described in this chapter.

When complete sets of harness are made, it is necessary that they should be made up at the India rubber factories, in order that the stays or eyes may be cemented in for the buckle holes, and that the caoutchouc whalebone ivory and enamel may be joined to such parts as require it, while the materials are in a soft state, and being manufactured.

The improvements alluded to, by which the difficulties are removed in the manufacture of harness, are, caoutchouc harness leather, and the method of staying the buckle holes, briefly described at the end of this chapter ; and caoutchouc whalebone and the semi-hard or non-abrasive compound, described Vol. I., Chapter II.

HORSE-COLLARS.

Attempts were formerly made, both in England and the United States, to manufacture horse-collars of native gum-elastic, to be inflated with air; but these attempts were not successful. The writer, also, made specimens of vulcanized horse-collars, both inflated with air and stuffed in the usual manner, in 1843.

The chief objection to these articles, at that time, was that of galling and sweating the horse.

The kind of collar to which these fabrics are best adapted, is one recently invented, as represented plate , fig. , it is made by a combination of gum-elastic sponge and whalebone, formed in moulds. Perforations are made through the pad oı the collar to admit the free circulation of air; that part of it which comes next the horse may be lined with woolen or leather, after the collar is finished, to prevent the gum from galling the horse.

HARNESS SADDLES.

The trees and skirts of these saddles are made of caoutchouc whalebone. The hooks and turrets are plated with caoutchouc enamel. The pads are made either of perforated gum-elastic sponge or of the quilted caoutchouc fabrics. See plate , fig.

HARNESS BRIDLES.

The blinders of gum-elastic harness bridles are made of caoutchouc whalebone, the bits and buckles are plated with caoutchouc enamel, and the reins are made of caoutchouc harness leather; a part of the check-rein being made of elastic compound. See plate , fig.

COVERED BUCKLES.

The covering of bucklés with caoutchouc enamel is fully demonstrated to be a valuable improvement. They are manufactured of different colors cheaper, and are better when made, than those that are covered with animal leather.

BAGGAGE STRAPS.

Baggage, trunk, and other straps are made of caoutchouc harness leather, the buckle-holes being stayed by strong linen cord or metal wire, cemented in around the holes or before them, in such a manner as to hold firmly, and prevent the buckle-tongue from tearing out. See plate xxv., fig. 9.

ELASTIC STRAPS.

The baggage, trunk, and other straps above described, are much improved by inserting from one to two inches in length of elastic stayed fabrics, in the strap near the buckle of the strap.

Straps made of animal leather may be made elastic in the same way, by which means they are more easily managed, and bind any article more securely, than those that are unyielding or non-elastic. See plate xxv., fig. 10.

COLLAR PADS.

These are manufactured of ventilated quilted fabrics, or in moulds, in the same manner as horse-collars, being subsequently lined with woolen stuffs, to prevent their galling the horse. See plate xxv., fig. 11.

TRACES.

These are manufactured at the factories only, and are made of caoutchouc harness leather, with the buckle-holes stayed in the same way as the elastic straps before described. There is, perhaps, no article of gum-elastic, or any part of gum-elastic harness, that is made with so great a saving of labor as the traces. This economy of labor is fully demonstrated by the fact, that one girl will make up twenty pairs of gum-elastic traces per day, while it is a day's work for a journeyman saddler to stitch a single pair of traces made of animal leather. See plate xxv., fig. 12.

REINS.

The round parts of these are made of caoutchouc harness leather. The hand-rein is made of the same material, either napped or covered with a light woven fabric.

CHAPTER XXI.

STAGE COACH, AND CARRIAGE TRIMMINGS.

Coach curtains. Improved coach curtains. Hammer-cloths. Coach lace. Coach boots. Wagon and chaise boots. Baggage boots. Baggage covers. Box cushions. Coach and chaise cushions. Improved box, coach, and chair cushions. Improved cushion covers. Carriage dashers. Coach whips, riding whips, and switches. Coach mountings. Coach trumpets. Improved coach and car sashes. Improved blinds. Improved carriage dashers. Coach pannels.

Some of these articles which are made of vulcanized gum-elastic, may be considered important on account of their cheapness, in comparison with those which have heretofore been made of other materials for the same purpose.

Others, because this material is comparatively indispensable for their manufacture on account of its water-proof qualities.

Of the latter sort are the cushions for waggons and the driver's box, hereafter described. With the stuffed cloth and leather cushions which have been furnished, drivers are exposed to a vast deal of hardship and suffering during storms, and the evil does not end with the storm. The cushion, or rather the sack of stuffing, becomes completely saturated with water, which continues to endanger their health even more than before, because it seldom, if ever, becomes dry.

The napped and plated fabrics might be highly recommended for the lining of stages and coaches throughout, on the score of quality and cheapness, except that the odor of them may be considered objectionable for close and expensive coaches.

In reply to this objection it may be urged, that as the gum-elastic linings acquire age, they will become free from odor, and remain much more cleanly than cloth linings.

They will not, like cloth, become impregnated with filth and

odor after being much used, more offensive than that of India rubber. They have the further recommendation of not being damaged by the driving in of the rain.

COACH CURTAINS.

Plated canvas is much used for coach and wagon curtains The best article of this kind is made of knit fabrics, plated with caoutchouc, and finished in imitation of enameled leather.

When coach curtains are made of knit goods, the elasticity of the curtain allows it always to be buttoned tightly, an advantage which is often missed in leather curtains, on account of their shrinking.

IMPROVED COACH CURTAINS.

This curtain is constructed as represented in plate xxvi., fig. 1, with an opening in the middle, and a fall or cover so arranged with buttons or strap that the passenger may open or shut it to obtain light or air without calling upon the driver. In a public stage coach it is a comfort or convenience that may be enjoyed by an individual without intruding upon others.

HAMMER-CLOTHS.

Gum-elastic hammer-cloths are commonly made up with needles, of plated caoutchouc cloth or canvas, napped in imitation of broad-cloths. An article is also made up in the same way, of plated caoutchouc fabrics, and is used as a covering for the broad-cloth hammer-cloths heretofore made. When the article first

described is used for this purpose, there is not only a great saving in the cost, but there is no occasion for the expense of a covering to protect them from wet.

COACH LACE.

This article is manufactured of napped and embossed gum-elastic fabrics, equally ornamental, and much more durable than woven lace.

COACH BOOTS.

These are made of plated and napped gum-elastic canvas, either at the gum-elastic factories or with the needle. The napped canvas presents a woolen surface on the inside, and forms a warm lining, it is most suitable for this purpose, although the plated fabrics not napped may be lined with other goods, like the leather boots which are commonly used. See plate xxi., fig. 1.

WAGON AND CHAISE BOOTS.

These are manufactured in all respects like the coach boots before described, only they are made of a lighter description of materials. See plate xxi., fig. 2.

BAGGAGE BOOTS

Are made of plated and barred gum-elastic canvas felt. They are used for protecting from the weather the baggage placed upon the rack at the hinder part of the coach. See plate xxi., fig. 3.

BAGGAGE COVERS

Are manufactured of plated canvas or strong corded and barred vulcanized fabrics, to suit the coach or vehicle for which they are intended, a suitable number of holes being made around the edge of the cover, by which it is secured over the baggage. See plate xxi., fig. 4.

BOX CUSHIONS.

These have been manufactured in different ways, both stuffed and inflated with air, but they have not commonly been made substantial enough for this use. When properly made, they may be considered more durable than any other kind of cushion, and do not expose the health of the drivers like leather or cloth cushions, which are commonly saturated with water, or frozen from their exposure to the weather.

COACH AND CHAISE CUSHIONS.

See Chapter XXVIII., Air-work.

IMPROVED BOX, COACH, AND CHAIR CUSHIONS.

These cushions are manufactured of perforated gum-elastic fabrics, and stuffed with different materials. In a square cushion, five sides of the cushion are made of the above material, and one side water-proof, with the same fabric unperforated.

The improvement consists in constructing it so that it will be cool in warm weather, and on being turned over, water-proof in storms. See plate , fig. .

IMPROVED CUSHION COVERS.

These are constructed of perforated gum-elastic fabrics, so as to open at the side to admit a cushion of any kind. They are otherwise made upon the plan of the cushions last described, so that one side of the cover is water-proof, while the other sides are porous. See plate , fig. .

CARRIAGE DASHERS.

These are made of vegetable leather, finished in imitation of patent japanned leather, and are designed to answer the purpose of japanned leather dashers. The material of which they are made can be furnished at much less expense than japanned leather, and the expense is lessened much more when the goods are cemented to the frame at the factories. The lustre upon these goods is not so hard, and is, therefore, more easily scratched than japanned leather, but the goods resist the action of the sun and weather much better, and without cracking.

COACH WHIPS, RIDING WHIPS, AND SWITCHES

Are manufactured of caoutchouc whalebone, made in moulds in one entire piece. The cheapness and elegance of these whips give assurance of the success of the manufacture.

Flexible team whips are described, Chapter XIX. See plate xxi., figs.
bottom and on the sides, of either the window sash or casing, from one-quarter to one-third of an inch in diameter, and com-

COACH MOUNTINGS.

Different parts of the mountings of coaches and carriages may be covered with India rubber enamel much more cheaply than with brass or silver plate, and may be made much more finished and beautiful than those japanned or covered with leather.

COACH TRUMPETS

Are manufactured from caoutchouc ivory, connected with a flexible gum-elastic hose, covered with braid, velvet, or other stuffs. The use of this trumpet is to communicate with the driver from within the coach. See plate , fig. .

IMPROVED COACH AND CAR SASHES.

An improved sash may be made for coaches, cars, and omnibuses, as well as dwellings, by means of a packing of gum-elastic sponge cord, drawn into a dove-tailed groove around the edge of the sash: this packing operates to keep out the dust and rain, to prevent the annoying rattling noise of vehicles, and also to keep the sash in the place when it is raised. See plate , page .

IMPROVED BLINDS.

An improved blind or screen is manufactured by the use of the finely perforated fabrics, which are designed both for dwellings and travelling vehicles. They operate to exclude the sun, dust, and insects, and to admit air and light. The improved sashes before described, may be constructed in this way, as well as common window screens and shutter blinds. See plate , figs. .

IMPROVED CARRIAGE DASHERS.

This article is manufactured of caoutchouc whalebone, in one entire piece, made in moulds; they are stiffened around the edge either by an extra thickness of whalebone, or an iron rim in the same manner as those heretofore made of leather. See plate , fig.

COACH PANNELS.

Coach pannels may be advantageously veneered with caoutchouc whalebone, and when the supply of gum-elastic is sufficient for such uses, entire coach bodies may be made of the same material with still greater advantages. In this case, the mortices and the tenants which unite the parts will be made of cast iron, inserted while the gum is in a plastic state, and the parts are being moulded.

CHAPTER XXII.

FANCY AND ORNAMENTAL USES.

Daguerreotype frames and boxes. Fancy boxes. Looking-glass and picture frames. Improved picture frames. Portable picture frames. Ornamental mouldings. Fancy baskets. Gimps. Coach lace. Banners and flags. Fringes and tassels. Pocket-books and wallets. Walking sticks, or canes. Meerschaums. Medalions. Cameos. Umbrella and cane heads. Plated ornaments.

Numerous fancy and ornamental articles may be made from the different vulcanized caoutchouc compounds, including the whole assortment that have heretofore been made of gutta percha in its native state. Some things made of the softer compounds, such as gimps, fringes, tassels, &c., are of less importance; but it is obvious that those articles which are made of the hard compounds entirely, and also those which are enameled with these materials upon wood and metal, are better on many accounts than the same articles made of many other substances. The superiority of articles made of these materials consists,

First, In their extreme hardness and susceptibility of polish, which is given them simply by the smoothness of the forms in which they are vulcanized.

Second. They are not liable to crack or warp.

Third, They are much harder, and stronger than the same articles made of wood, plaster, and other compounds, because they are made in one entire piece without seam.

Fourth, They admit of the numerous styles of finish, like other substances, such as inlaying, embossing, &c., while the expense of manufacturing is less than that of the same things made in separate parts of wood, and other materials. It is sufficient to specify a few of the applications of the substances for these purposes.

DAGUERREOTYPE FRAMES AND BOXES.

Are manufactured of caoutchouc ivory and whalebone. The frames are much lighter, stronger, and more durable than those made of wood. The tops, and also the bottoms of these boxes are made of one entire piece, in moulds ; they are stronger and more durable than those made of wood, covered with leather.

FANCY BOXES.

Fancy boxes of all kinds, together with many small articles appertaining to them, are made of the hard caoutchouc compounds. Among these may be enumerated, dressing-boxes, work-boxes, snuff and tobacco boxes, &c. They are made plain and polished, or with little expense are beautifully inlaid and embossed.

LOOKING-GLASS AND PICTURE FRAMES.

The same general remarks that have been made as regards the qualities of daguerreotype frames may be applied to looking-glass and picture frames. Another desirable quality of these frames is their lightness, as they can be made very thin owing to the great strength of the materials, and being manufactured in moulds, in one entire piece.

IMPROVED PICTURE FRAMES.*

This article is made of caoutchouc whalebone. It is manufactured in the same way as other caoutchouc whalebone picture frames, with the addition of a revolving roll at the bottom, such as is sometimes used for rolling up coach curtains. This roll, which is self-acting by means of a spiral spring coiled within it, operates to roll up any fabric that is attached to it. It is placed behind the frame at the bottom, and the scroll upon it is drawn out by a tassel. It is proposed to make these scrolls of gum-elastic tissue or drapery, on which a catalogue or any description of the subject may be printed. See plate xxii., fig.

* Invented by Mr. John Wood, Philadelphia.

PORTABLE PICTURE FRAMES.

See Chapter XXIV.

ORNAMENTAL MOULDINGS.

The superiority of these materials for ornamental mouldings, for furniture, &c., compared with native gutta percha, is worthy of notice.

These articles made of the caoutchouc whalebone are not only much lighter, but stronger than when made of the native gutta percha. They are not, like gutta percha, easily indented, and are not softened by a hot sun, or hot water, and will bear harder blows without indentation than brass or iron.

FANCY BASKETS.

Work-baskets and other fancy baskets are made of wicker-work, such as is described in Vol. I., and of whalebone thread instead of willow or cane, they are also made of thin sheets of perforated caoutchouc whalebone. The advantages in the use of these materials for baskets are, that they are very durable and are not injured by being crushed.

GIMPS.

Gimps are made of vellum cord; black gimps may also be made of threads or strips of caoutchouc whalebone.

COACH LACE.

See Chapter XXI.

BANNERS AND FLAGS.

Gum-elastic vellum and tissue are cheap and durable articles for banners and flags. The reader will be able to form his own judgment of the suitableness of the fabrics for this use, from the maps and plates of this work.

FRINGES AND TASSELS.

These are made of gum-elastic cord, which is spun and twisted while the gum is in a soft state, with the same facility as common thread.

The brilliancy of color is not in all cases equal to that of dyed silk, but it possesses the advantage of being unfading, and the goods are not readily injured by being soiled. Articles of this sort may, at least, be found useful for coach trimmings, &c.

POCKET-BOOKS AND WALLETS.

These are made of gum-elastic vellum in imitation of morocco, calf-skin, and Russia leather. Tissue is suitable for lining them, and for gussets, as well as for the gussets of pocket-books made of leather. These goods seem adapted to every variety of pocket-books and portfolios, which are subjected to usage that exposes them to friction and dampness; such usage tends to destroy leather very soon, but makes comparatively little impression upon the gum-elastic fabrics.

WALKING STICKS OR CANES.

Although there are numerous kinds of natural wood that are both cheap and beautiful, and good enough for this purpose, yet the caoutchouc whalebone has been deemed so well adapted to this use on account of its toughness, hardness, and elasticity, that it is the first article of the hard compounds of which the regular manufacture is commenced. These canes, which may be afforded cheaper than canes made of the finer kinds of wood, possess great advantages over them in point of lightness, strength, durability, smoothness of surface, beauty and variety of colors, and brightness of polish.

MEERSCHAUMS.

The caoutchouc compounds are well-adapted to the manufacture of meerschaums.

The caoutchouc enamel and ivory, when lined with porcelain or metal, is suitable for the bowls, and the elastic compound and whalebone are equally adapted for the tubes and stems of meerschaums. See plate , fig. .

MEDALIONS.

Medalions are made of caoutchouc ivory and whalebone, in exact imitation of bronze, both as to color and finish. These medalions are light, and have the hardness of marble ; they are less liable to injury in handling than either silver, gold, or bronze, and are moulded with equal facility as plaster, after which they are vulcanized.

CAMEOS.

Cameos and broaches of different kinds are manufactured of caoutchouc ivory, which closely resemble those which are made of other materials. This substance has a decided advantage for these uses, such as lightness, strength, combination of colors and facility of manufacture; but before deciding that there is any improvement to result from this application, it may be necessary to know whether a material can be adopted for ornaments which is not "dear bought and far fetched."

UMBRELLA AND CANE HEADS.

The heads of umbrellas, canes, whips, and other articles are manufactured of caoutchouc ivory and whalebone with economy and advantage. They are moulded with the same facility as pressed horn, and are equally, if not more durable, than any other material from which such articles have heretofore been made. See plate , fig.

PLATED ORNAMENTS.

Some ornamental, as well as numerous useful articles, are made according to an invention that is briefly described in Vol. I., page 111, of this work. It consists in plating or covering the articles with silver or gold foil, such as canes, walking sticks, whip heads, &c. Other articles, such as drinking cups, pitchers, trays, servors, &c., are lined in the same way, upon the inside. In both cases the work is done by placing the foil upon the article where it is fastened by the pressure of the mould, when the article is vulcanized.

CHAPTER XXIII.

AIR-WORK.

Air-work. Self-inflating air-work. Cushions. Boat cushions. Ventilated boat cushions. Self-inflating cushions. Ventilated cushions. Invalids' cushions. Coach, chaise, and box cushions. Pillows. Self-inflating pillows. Ventilated pillows. Beds. Cape and poncho beds. Ventilated beds. Self-inflating beds. Hospital air-beds. Observations on life-preservers. Life-preservers. Pocket life-preservers. Cushion life-preservers. Pillow life-preservers. Satchel life-preservers. Jacket life-preservers. Nautilus life-preservers. Self-inflating nautilus. Life-preserving wearing apparel. Life-preserving bathing dresses. Balloons. Gas bags. Directions for mending air-work.

This is a term which has been technically applied to all articles that are inflated with air. It was to such articles as beds, pillows, life-preservers, cushions, &c., that India rubber was, in the early stages of the manufacture, most commonly applied, and from them the greatest advantage was, at that time, expected; perhaps even more than from clothing, shoes, or suspenders. Little benefit, however, has been derived from air-work as yet, in comparison with other branches of this manufacture; the demand for this class of articles has increased very little, if at all, since 1838, and notwithstanding the improvements made in the gum by the heating or vulcanizing process, air-work has not come into favor with the public as might have been anticipated. The reputation of this class of goods was nearly lost from the imperfect manufacture of the goods, before the heating or vulcanizing process was introduced, and from the use of metal tubes, to which gum-elastic will not adhere firmly.

The cost of the articles, considering their liability to be lost, by the slightest damage or defect causing leakage, or escape of the air, has been quite too great. This expense has been owing partly to a limited demand, but very much to the complexity of their construction, and the quantity of materials necessary to

make them, as may be seen by any one who has an opportunity to examine the internal construction of a bed, or cushion, of the common kind. The odor of the goods, and their being uncomfortably warm, have presented, in addition to the cost, the great objections to their use.

By the use of the gum-elastic tube, which is cemented in so as to form part and parcel of the article, the danger of leakage in that part is completely removed; and in the ventilated air-work, the objection of warmth is wholly removed. By the new method of manufacture by machinery, in the use of the laminated fibrous fabrics, an entire change in the manufacture of air-work is anticipated. The peculiar properties of these fabrics, and method of manufacture alluded to, lead to the conclusion that cheaper and better articles will be produced. And it may be hoped that in consequence of the improvements here noticed, and the reduction of the cost of the articles, they will eventually come into as general use as was at first anticipated.

The mechanical construction of air-work is chiefly of three kinds. That which was first made, and was one of the earliest manufactures of gum-elastic; ventilated air-work, which has been described, Vol. I., page , and the self-inflating air-work, described as follows:

SELF-INFLATING AIR-WORK.

This is a style of work, some specimens of which were made by the writer as early as 1838, but it could not then be made to any advantage, in consequence of the gum peeling off the woven cloths, and causing the compartments to pull apart, and owing to their want of sufficient firmness. In consequence of the improvements described in this work, it is believed that this class of air-work may now be made with advantage.

It is somewhat more expensive and difficult to manufacture than other kinds of air-work described in this chapter, but it is

much more convenient on account of its being easily filled, simply by pulling it open. The labor of inflating air-work, and particularly beds, whether with a bellows or the mouth, has ever been found a great objection to it. This objection does not apply to the work here described, as it can be filled instantly when needed; and when not in use it may be packed away in a very small compass. The method of constructing this article, although it might appear very complicated, is indeed very simple. Every compartment is first formed separately. A sufficient number of them to form the article are next cemented together firmly, about half the distance from the centre to the outer edge. The different compartments are each inflated by separate tubes, or any number of them are inflated by one tube, when they are so constructed that the air may pass from one to the other.*

Thin sheets of India rubber whalebone board are cemented in between the cells, which, if they should become leaky, render them more firm and safe when in use, by keeping them from collapsing even.

This contrivance now makes this article available, which was before useless for the want of firmness in the cloth to cause the article to inflate itself. It also gives the article that degree ot stiffness which causes it to resist the pressure of the water, and prevents a leak from rendering it unsafe, which would cause one of the common kind to collapse and sink immediately.

CUSHIONS.

These were among the articles first manufactured of the McIntosh fabrics, both in Europe and the United States, but neither these or the different kinds that have since been made, have been much used in comparison with what might have been expected, considering the length of time since they were first

* The life-preserver being more or less safe according to the number of cells inflated by each tube.

introduced. The reasons have been, undoubtedly, their expensiveness, their liability to be damaged, so that the air would escape from them, and their being uncomfortably warm.

It is believed that, by the new method of manufacture from the fibrous fabrics, they will now be furnished at extremely low prices. The objection of warmth is entirely removed in the ventilated articles, so that they are even cooler than other stuffed leather or cloth cushions, and the risk of damage to those filled with air, need hardly be considered, since when they are not made so as to be stuffed through the tubes, they may be cut open underneath and stuffed, so that they will answer all the purposes of leather and cloth cushions, after they are damaged. Those inflated with air are often found very comfortable for invalids. Their superiority is most apparent when used for riding, either in coaches or wagons. A journey will be found much less fatiguing with them than with any other cushion. Those made of the light fabrics, and the self-inflating, are designed chiefly for this purpose, as they may be packed in so very small a compass that they may be carried in the pocket for occasional use. Settees, as well as chair cushions, especially those that are made in separate compartments, may be highly recommended for use on board of steamers and vessels, since, when trimmed for the purpose, with suitable fastenings, they will form infallible life-preservers. The common patterns, inflated by a single tube, are represented in plate xxvii., figs. 1 and 2. Those made in separate compartments, and inflated by a number of tubes, are represented by fig. 3.

BOAT CUSHIONS

Are made of plated canvas or elastic knit goods, and inflated by one tube, as represented by plate xxvii., fig. 4, or like fig. 5, with a self-acting valve tube in each compartment, in order that they may be stuffed, if desired. In case of accident, these

cushions will form an excellent life-buoy, for which reason they should not be so firmly attached to the boat as to prevent their being used in case of accident.

VENTILATED BOAT CUSHIONS.

These are manufactured of quilted fabrics, perforated between the compartments or cells, as represented, plate xxvii., fig. 6.

This style of work is particularly adapted to boats, for the reason that the water is immediately drained off from them.

SELF-INFLATING CUSHIONS.

Self-inflating cushions may be best made of plated fabrics, and may be recommended chiefly on account of their compactness when collapsed, and of the ease with which they are filled like other self-inflating articles. When they are made with the self-acting valve tube for each compartment, in case they become damaged so as not to retain air, they may be stuffed through the tubes with any suitable material, such as ground cork, chopped gum, elastic sponge, curled hair, or moss, in which case they will answer all the purposes of a stuffed leather cushion. See plate xxvii., fig. 7.

VENTILATED CUSHION.

These are made of the quilted fabrics, to be inflated with one tube, as represented by fig. 8, plate xxvii., or with a tube for each separate row of cells, as represented by fig. 9. Cushions of this pattern are not liable to the common objections to air cushions, that of being uncomfortably warm, and rolling about.

INVALIDS' CUSHIONS.

See Chapter

COACH, CHAISE, AND BOX CUSHIONS.

See Chapter .

PILLOWS.

The style of pillow represented by fig. 10, is also one of the articles first made in England and the United States, of the Mc Intosh fabrics. When made of the plated fabrics, and inflated with the gum-elastic self-acting tube, this is the cheapest of the various kinds of cushions.

If inclosed in a pillow-case, and trimmed with suitable fastenings when used on shipboard, they may also be used as life-preservers. The chief objections to this pattern are their warmth, and their liability to roll about.

SELF-INFLATING PILLOWS.

Like other self-inflating air-work, these are manufactured to be inflated with one tube, or with a tube to each compartment, they are designed to be used on shipboard as pillows, and if required, as life-preservers; although, like the kind before described, they are objectionable as pillows on account of their warmth. See plate xxvii., fig. 11.

VENTILATED PILLOWS.

The objection to gum-elastic pillows, on account of their warmth and rolling motion, is almost wholly, if not entirely removed by the invention represented in plate xxvii., fig. 12. When folded, it is used for a pillow; when opened, as represented, plate , fig. , it is designed to be used as a life-preserver when required. This may be considered one of the safest kinds of life-preservers, especially when stuffed with cork or curled hair, on account of affording protection from injuries to the person.

BEDS.

The air bed, represented by fig. , plate , is one of the articles first made of the McIntosh manufacture; and when made of the plated fabrics, after the method described, page , is the cheapest article of air beds; although the same pattern, represented by fig. , with a tube for each compartment, is much more secure from being damaged, and is not much more expensive.

CAPE AND PONCHO BEDS.

These are manufactured of the improved air and quilted fabrics, described Vol. I., page .

When each row of compartments or cells in this poncho, which are usually from thirty to fifty, are inflated by a separate valve tube, at least two-thirds of them must be damaged before the bed will be unsafe in the water.

Where the cells, in all about six hundred, are stuffed with curled hair, each being separated from the other, two-thirds of these may be rent or damaged before the bed will become unsafe as a life-preserver. See plate , fig. .

VENTILATED BEDS.

These are also made either of the air-work or quilted fabrics, and perforated, as represented in plate , fig. . Their chief recommendation is that they are not like other gum-elastic beds, uncomfortably warm in hot weather, and when the rows of cells are inflated by separate tubes, and especially when stuffed with curled hair, they are more secure from being damaged than any other gum-elastic bed.

SELF-INFLATING BEDS.

These are manufactured like other articles of self-inflating air-work, and are inflated either with one tube, or with separate tubes for each cell or compartment.

On account of the ease with which they are filled, and the certainty of their retaining the air when the cells are inflated separately, they are superior to other air beds for persons who are travelling, when they are not certain of finding beds, or are not satisfied with the quality of those they do find.

HOSPITAL AIR BED.

See Chapter

OBSERVATIONS ON LIFE-PRESERVERS.

In addition to the circumstances that have been noticed, which have tended to prevent India rubber air-work from coming into general use, there are others which have operated against life-preservers in particular.

These articles, in whatever form they are made, are in no case to be depended on as infallible life-preservers, when simply inflated with air in one apartment, as they have commonly been made. The self-inflating life-preservers, which are kept distended by braces of whalebone board, and the nautilus life-preservers, are much the safest. The common kinds, also, of different patterns, particularly those which are made in two or more compartments, with separate tubes, (as they may now be afforded at extremely low prices,) are useful either as swimming belts or life-preservers, and may save many lives, if they are not too much depended on, to the neglect of other means of safety; but if they are, as many lives may be lost as saved by the common kinds, filled with air only. It is well known that some lives have been saved by them; an instance, however, has come to the knowledge of the writer, of the captain of a ship who ran the risk of leaving his vessel, depending on a life-preserver, and was lost, while those who remained in the vessel were saved.

The value of an article depends chiefly upon the certainty of its answering the purpose for which it is designed. When it does so, and the purpose is a good one, if the price is reasonable, the article is sure to come into general use.

An instance which enforces this idea is found in the fire-proof safe. Notwithstanding its expensiveness, it has, in a few years, come to be considered among merchants an article of necessity; whereas, although it is twenty years since life-preservers were first introduced, yet they do not come into favor as was expected, nor as they would have done if they had really been what they

are called, "Life-Preservers." Notwithstanding the price has been reduced to one-half what it was, yet the demand and sale of them is not half so great as it was fifteen years ago.

One great difficulty in making life-preservers, as well as every other description of air-work, to answer the purpose for which it is designed, has been the impossibility of uniting India rubber to metal, and none but metal tubes have, heretofore, been used for inflating them. Although when first made with these tubes they may be tight, very often, after a little wear, the air escapes between the gum and the metal. By the invention of the gum-elastic tube, (which is also self-acting, and much more safe on that account, and which can be made for a trifle in comparison with the metal tube,) this difficulty with metal tubes is completely obviated.

By removing the defects which have been enumerated, by the improvements treated of in this work, it is hoped that gum-elastic life-preservers, which are really of great value, if well made and properly used, may be made great blessings to mankind.

LIFE-PRESERVERS.

The kinds of life-preservers with which the market has been chiefly supplied, are represented by figs. 1, 2 and 3, in plate xxvii. They are less safe than any of the other patterns that are represented in the plate. The article represented by fig. 4, is after the same pattern as fig. 1, made in the same way, except that the compartments do not communicate, and they have each a separate tube. This arrangement, which is a consequence of the invention of the self-acting gum-elastic tube, makes life-preservers, filled with air only, comparatively safe, although they are more troublesome to inflate than the self-inflating air-work. The metal tubes formerly used would not only be too heavy, but quite too expensive for such an arrangement with many tubes, even if there was no other objection to their use.

POCKET LIFE-PRESERVERS.

This article is made as represented by fig. , plate xxvii., and is designed to be put in cloth garments, such as vests, coats, and cloaks. When the compartments are inflated by separate tubes, they may be considered quite safe, and the more so, because they are protected from damage by the garment. They may be considered the cheapest, most unobjectionable, and convenient of all life-preservers which are filled with air only, as they are always at hand with the garment, and may be worn sufficiently inflated to save a person from drowning, when there is any apprehension of danger, without attracting the observation of others. This may be deemed an important recommendation, as many persons, and particularly sailors, would sooner be exposed to drowning than to ridicule from wearing a bag of wind, although in the form of a life-preserver.

CUSHION LIFE-PRESERVERS.

This is the same article, designed for ship's use, described as a cushion when folded, page . When quilted or inflated by separate tubes for each compartment, it is among the safest of life-preservers.

PILLOW LIFE-PRESERVERS.

This is another of the articles designed for ship's use, and described as a pillow, page . When unrolled, put on over the head, and fastened around the person, this is also one of the safest of life-preservers, because it affords the best protection to the person from blows or injuries.

SATCHEL LIFE-PRESERVER.

This article is the same as that described as a double satchel, or travelling-bag, page . When filled with clothing, or inflated with air, it answers the same purposes as the two kinds before described, as a life-preserver.

JACKET LIFE-PRESERVER.

This form of life-preserver has been introduced to some extent in the United States.

When the article is made in separate compartments, and inflated in separate tubes, it may also be considered a good and safe one. An improvement has recently been made in these jackets by perforations between the compartments, like the ventilated cushion life-preservers. See plate , fig. .

NAUTILUS LIFE-PRESERVER.

The nautilus life-preserver, which is represented by fig. , was patented in the United States in 18 . It consists of a spiral wire, covered with gum-elastic fabrics, in one apartment, but is somewhat objectionable on account of its bulk. This article may be considered a safe life-preserver, but not so safe as the self-inflating nautilus.

SELF-INFLATING NAUTILUS.

This is manufactured like the self-inflating beds and cushions before described, except that the stiffenings between the com-

partments are made of rigid whalebone board, instead of flexible caoutchouc whalebone.

When each compartment of this nautilus is inflated by a separate tube, it is not only one of the safest, but also one of the most compact of life-preservers.

LIFE-PRESERVING WEARING APPAREL.

See Chapter

LIFE PRESERVING BATHING DRESSES.

For descriptions of these, see Chapter , and diagrams, plate , figs. 18, 19 and 20.

BALLOONS.

It has often been suggested to the inventor by others, that the vulcanized fabrics would answer well for balloons. As yet there has been no trial of the article upon a large scale, but from repeated trials upon a small one with globes, there is every reason to suppose that the corded gum-elastic vellum would answer well for this use; and if so, it would certainly be stronger, and cost less by half than oiled silk. The cost of a silk fabric, coated with gum-elastic for this purpose, would be about the same as that of oil silk, although being cemented instead of stitched, the workmanship of the gum-elastic balloons would be much the most complete, and cost much less than that of the oil silk, as they are now made.

GAS BAGS.

DIRECTIONS FOR MENDING AIR-WORK.

When any article of air-work is damaged, the place where the air escapes may often be detected by applying it to the face or ear. When the article is fully inflated, a surer way is to wet it upon the outside, or immerse it in water, when, on being pressed with the hand, the leak will commonly be found by the bubble which is caused. A more searching trial is, to fill the article wholly or in part with water, and press it. The escape of air must be very slow, and the leak of little or no consequence, not to be found in this way.

When found, a few drops of gun cotton varnish, or what is called collodion, applied to the spot, will often effectually stop a small leak. A larger leak may sometimes be stopped with a few drops of hot sealing-wax, or shoemakers' wax. The above are recommended only as expedients where the vulcanizing cement is not conveniently to be found. If the rent is large, it should first be drawn up with a needle and thread, and the vulcanizing cement applied in two or three alternate coats, each of which dry in an ordinary temperature of a warm room in from fifteen to twenty minutes; the part which is coated with the cement should afterwards be exposed to the rays of the sun for about

half a day, for the purpose of removing the adhesiveness from the cement.

Another expedient for making damaged air-work useful, if not more valuable than before, particularly cushions and beds, is to cut the cells or compartments as neatly as possible on the under side, and stuff them with curled hair, moss, or any other suitable material; on the cuts being closed again, as above described, the articles will answer all the uses of those which are stuffed in the first manufacture.

CHAPTER XXIV.

MISCELLANEOUS.

Umbrellas. Parasols. Bank notes. Portable picture frames. Transparencies. Money belts. Tape measures. Wheel-barrow tire. Wheel-barrow shoulder-straps. Covered iron furniture. Umbrella frames. Bedstead castors and shoes. Chair shoes. Cartmen's wallets. Ox-buttons. Nose baskets. Grafting bandages.

The articles which are described in this chapter are such as are considered not to belong to any particular class of articles more than another, for which reason they are described as miscellaneous.

The diagrams which are given of some of these articles are interspersed among the different plates, as noticed in the descriptions.

UMBRELLAS.

Umbrellas were made of muslin coated with India rubber, by the Roxbury Company, as early as 1837; but owing to the adhesiveness and decomposition of the unvulcanized gum, the manufacture was abandoned.

The writer has ever considered this as one of the most appropriate uses of gum-elastic, and for years past has occasionally made an umbrella for trial, and at every trial he has been confirmed in his opinion of the utility of this invention, though

some modification of the fabric for this use has, until now, seemed desirable. The recent improvement of the fibrous fabrics will greatly facilitate this branch of the business, both on account of the cheapness and lightness of the material.

Umbrellas are made either of tissue, corded tissue, or plated muslin. The frames are covered with the scraps of the material. The covers being cemented together, are then cemented on to the frame, quite to the tips. By this means a large umbrella is obtained with a small frame. The fabric being quite non-elastic, the edge of the cover remains straight from tip to tip, by which means the curve which is unavoidable in cotton and silk umbrellas, is prevented. There are at least four inches gained in the spread or diameter of the umbrella; in other words, a twenty-eight inch frame umbrella made from these fabrics, is as large as a thirty inch covered with cotton or silk. Still more may be gained in the size of the umbrella, by extending the cover by a stay of non-elastic compound, beyond the tips of the frame. It should be understood, however, that when it is preferred, the same form and symmetry may be given to these as to cotton or silk umbrellas, by cutting with a curve, the edges of the sections of which the umbrella is made. Each seam is cemented to the bow its whole length, which gives additional strength and firmness to the cover, and fastens it more securely to the frame than is ordinarily done by stitching.

It is needless to say that these fabrics are impervious to water, and therefore umbrellas made from them form a complete shelter from rain. They are very durable, and do not absorb water to be carried within doors, like cotton or silk.

If there is any one purpose to which gum-elastic is adapted without objection, it is doubtless that of umbrellas.

PARASOLS.

This may be considered too fanciful an article to be manufactured from these fabrics at the present day, and yet it may be claimed that the drapery tissue, and corded tissue, and coated florence, are fine and delicate enough to answer this use. It, however, remains to be decided whether these fabrics are sufficiently freed from the odor of the gum to be used for this purpose. The parasol or shade, which is made without a frame, to be inflated with air through a caoutchouc ivory handle, with a valve at the end of the handle, is noticed simply as a curiosity, without any pretensions as to its practical utility. See plate , fig. .

BANK NOTES.

Specimens of bank notes have been made upon tissue, which are excellent imitations of tissue paper bank notes, and which, in many respects, and particularly as regards counterfeiting, possess great advantages over paper. The first cost of this material is greater than that of bank note paper, and whether it is an application, all things considered, that will obtain the approbation of banking institutions, is a subject for discussion. That they would be highly approved by the public if issued, there is little doubt, for the following reasons. Even if the secret of their manufacture were known, it would be an exceedingly difficult matter to counterfeit them. The counterfeiter would have an additional trade to learn, more confederates to employ, and would be much exposed in the manufacture to detection, by the chemical processes that are used, the fumes of which it would be difficult to conceal. In regard to cleanliness, these notes would possess immense advantage. Few substances are less objectionable on account of odor than these notes. They can be cleansed as easily as glass, by washing or boiling, without injury to the tissue or the engraving, which defies the powers of chemistry either to extract the ink or to alter the

signature. Bank notes in the United States are kept in circulation until they are completely worn out; they pass through hands of every hue, and through pockets of all grades, until they acquire an odor that would be quite insufferable in any other article, to those who have any regard to cleanliness. Should we not be as particular in respect to the cleanliness of money as to other things? The indifference of the public on this subject can hardly be accounted for, except upon the supposition of its being taken for granted, that there is no remedy. Notwithstanding the first cost of these notes being more, it is believed in the end they will be cheaper, on account of their greater durability.

PORTABLE PICTURE FRAMES.

Gum-elastic pictures, prints, and engravings are made with portable frames of the same material, which may be either gilded and bronzed to imitate wooden frames, or colored in imitation of different kinds of wood, all of which is done very cheaply. For further description of this kind of frame and its uses, see framed maps, Chapter I.

TRANSPARENCIES.

These are made of gum-elastic tissue. There may not only be a great saving of expense in the substituting the tissue for silk or canvas, for transparencies, but the work may also be lithographed or colored, in a style highly superior to that in which they are commonly executed.

MONEY BELTS.

These are made of coated gum-elastic vellum or coated florence, with the mouth so constructed that they may be made air and water tight, by which means papers and bank notes may be kept safe and dry; and if well filled, or inflated by means of the small tube which is attached, they answer in good part the purpose of life-preservers.

TAPE MEASURES.

These may be cheaply made of gum-elastic vellum, printed in the piece, and cut in strips. Besides the advantage of durability, they possess another, that of being quite inelastic. The desirableness of a good cheap article of this sort, is best known to carpenters and tailors.

WHEEL-BARROW TIRE.

This is an English invention for preventing the noise of wheel-barrows in ware-houses, at railroad stations, &c. For this purpose, a rim of vulcanized gum-elastic is fastened around the tire of the wheel-barrow.

WHEEL-BARROW SHOULDER STRAPS

Are formed of a strap made of gum-elastic plated fabrics, with a piece of stayed gum-elastic compound, from two to four inches in length, inserted in each end of the strap. The advantage gained by this, is to relieve the laborer of the jar of the barrow, by the elasticity of the strap.

COVERED IRON FURNITURE.

Iron furniture, such as bedsteads, chairs, settees, &c., has long been made, and although stronger, and evidently possessing many advantages over wooden furniture, it has obtained favor but slowly with the public.

This may be owing in a great measure to the forbidding aspect of the material, and to the idea one has of its repulsive properties, coldness and hardness; and possibly more or less to the idea that the bedsteads are dangerous to sleep on in a thunder-storm.

It is here proposed to make the article in the usual manner, either of wrought, cast, or malleable iron, or in parts as suggested by the diagrams, plate , and to cover them first with cotton wadding, and afterwards with vellum, colored in imitation of mahogany or rosewood.

Iron furniture is also enameled with caoutchouc enamel, in imitation of rosewood and mahogany, and various cther styles which surpass them in hardness and finish.
ticle, than in the use of furniture made of wood, especially where the gum-elastic shoes or castors are used.

UMBRELLA FRAMES.

Some recent experiments in the manufacture of umbrella frames from India rubber whalebone and ivory, give the writer assurance that this is a valuable application of this substance. An improvement is contemplated, and practically tested, so far as to make specimens of umbrella frames, by making use of gum-elastic in all the parts. The very great difficulty of making substantial joints with such slight materials as the frame of an umbrella is made of, must be apparent to all. The extremely low price of this description of work, will hardly allow the manufacturer to make them as carefully as they might be made. It would not be possible to make them so that they would not easily break or get out of repair, after the rivets and joints become rusty. The experience of almost every one has taught them, that loss and annoyance is the frequent consequence of these defects.

An improved umbrella is made by the use of caoutchouc whalebone instead of whalebone for the bows, elastic compound for the joints instead of wire and metal, India rubber fabrics for the covers, and gum-elastic ivory for the sticks.

BEDSTEAD CASTORS AND SHOES.

The metal part of these castors is made of the common form, with the difference that the wheel has a groove, into which a ring or tire of elastic compound is fitted, as represented in the plate , fig. . Shoes are also made for bedsteads, like the chair shoes hereafter described. The design of both the above articles is to prevent noise and the wear of carpets.

CHAIR SHOES

Are made of *gum-elastic sponge*, or elastic compound, in the same manner as hollow ware ; in this way an elastic ball or foot of any required shape is made, that is fitted into a socket which fits the foot of the chair, as represented in the plate , fig. 1 and 2.

The socket may be made of brass or iron, or of caoutchouc ivory. When made of the latter material, it is attached to, and forms a part of the shoe.

The improvement consists in preventing noise and the wear of carpets. Another consideration, which will probably be deemed of importance by many, is perhaps worthy of notice. It is a well-known fact, that gum-elastic is one of the best non-conductors of electricity. It is so completely so, that a person having on India rubber shoes, sitting upon a chair of this kind, or lying upon a bed provided with similar shoes, need have little apprehension of danger from lightning.

CARTMEN'S WALLETS

Are made of vegetable leather. They are commonly attached between the two front stakes of the cart, and used by cartmen as a sort of portfolio or pocket, for containing papers, or other light articles, which it is desirable to keep dry.

OX BUTTONS.

These are made of gum-elastic sponge, in the same manner as hollow ware, as a substitute for the metal article heretofore used.

The advantages of this article are obvious. They may be made much larger, and being lighter than those made of metal, they will not cause the horns of cattle to drop in their growth; and being soft, there will be less danger of vicious cattle goring one another, or their owners with them.

NOSE BASKETS.

Nose baskets are made of wicker-work, and may be suggested to the notice of those who are curious, or careful about the accommodations for their horses and cattle.

GRAFTING BANDAGES.

This article is made of heavy gum-elastic drapery, and is intended to keep the clay moist as well as secure, which is placed about grafts in grafting trees. In grafting trees for this purpose, there should be a large proportion of lampblack, or carbon, compounded with the gum, in order to make it stand well the effects of the sun and weather.

CHAPTER XXV.

APPENDAGES OF WEARING APPAREL.

Buttons. Suspenders, or braces. Improved suspender. Suspender ends. Ladies' elastics. Improved ladies' elastics. Stays, corsets, and braces. Pantaloon straps. Hat pockets. Hat covers. Hat and cap springs. Foot holders. Shoe springs. Improved shoe springs. Vest springs. Glove springs.

THESE appendages consist chiefly of a variety of springs, designed or arranged for the comfortable adjustment of wearing apparel. Particular attention has formerly been paid in Europe to the manufacture of these articles from the native gum, and the mechanical execution of them has therefore been brought to a higher state of perfection there than most other articles of gum-elastic. They are, however, fast being superseded, both in Europe and America, by articles of the same kind, (together with many others recently invented,) and made from the vulcanized gum-elastic.

BUTTONS.

Finding caoutchouc compounds applicable to buttons, a branch of business which the writer supposed he had long ago relinquished altogether, his early associations are awakened, and were it not a digression, he would be strongly inclined to write a lengthy article on the art of button making, which, with many interesting particulars connected with it, would afford ample materials for a volume. As a branch of industry and merchandise, few persons consider the extent or importance of it, or that this trifling article is indispensable for comfort and convenience, making a large item of necessary expenditure, as well as that

which is connected with fashionable display. It is curious to observe of what variety of materials buttons are already made, viz., wood, bone, horn, ivory, shell, pearl, tin, iron, steel, brass, britannia, gold and silver plate, and sometimes of gold, silver, and precious stones, together with combinations of the above materials and silk, linen, woolen, and cotton threads and stuffs. Added to all these, caoutchouc is deserving of notice for buttons. Its water-proof quality resisting the effects of boiling water, also the economy and facility with which this material is worked, recommend it for this use, particularly for the dead eye and cheaper kinds; and also for the more expensive kinds, which are cheaply made from this material in imitation of bronze, metal, figured or plain lasting, silks, and other stuffs.

SUSPENDERS, OR BRACES.

This is an article, the sale of which is divided among a great variety of kinds.

Vulcanized gum-elastic thread has recently been applied to numerous kinds of suspenders, which have heretofore been made of the native gum thread; as well as to other kinds that have recently been invented, such as the shirred suspender, and those made of vulcanized gum-elastic fabrics, felt, and other webs with elastic ends. This is one of those articles with which fashion has much to do, and the choice among the different kinds depends so much upon the fancy of the wearer, as well as upon the real utility of the article, that it may be considered presumptuous in any one to assert absolutely what kind is best. Among them all, the writer thinks the kinds most deserving particular notice, are those represented in plate xviii., figs. 1, 2, 3, 4, and 5. Figs. 1 2 and 3 may be considered most complete and unobjectionable, among the most expensive kinds. The webs of these are firm and unyielding, which may be the most fanciful and expensive, or plain and substantial; in either case the most complete elasticity of the suspender is in a simple and cheap manner

obtained from the ends, both back and front, which are made of vulcanized gum-elastic cord, about one-fourth of an inch in diameter, braided over with sewing-silk, or the best cotton thread.

IMPROVED SUSPENDER.

Two other kinds of suspenders have been recently invented by the writer, which he supposes may, all things considered, be found cheapest and best for the greatest number, the first described is represented in plate xviii., by figs. 4 and 6. The webs are made of elastic vulcanized fabrics, with two or more button-holes cut in the back ends, and two or more gum-elastic buttons or studs attached upon the front ends. The object of this invention is to furnish a suspender without buckles. Suspender ends with buckles may be used with these, as with other suspenders, yet those made of elastic compound stayed goods, represented by figs. 6 and 7, are specially designed for them, and when used with studs, or gum-elastic buttons cemented on them, the suspenders are made without a stitch. The goods are printed in the piece; and when cut up and the buttons are attached, and the button-holes punched, the suspenders are finished. It may be objected that they cannot be taken up or let out so exactly as with the buckle. This objection is found to be unfounded on trial, the end being so very elastic that a slight difference in length is not observed by the wearer; besides, where the buttons or button-holes are placed at distances apart, especially if two or more button-holes are cut at the back end, the variations of length can be made as great, and with as little inconvenience, as with the buckle, where the means of lengthening and shortening exist only in front.

The other improved suspender alluded to is made of plated porous caoutchouc fabrics, printed in the piece. Strips of elastic compound, of from one to two inches in width, are cemented into the piece across it, at such distances apart as will give a

spring for each suspender. When this fabric is cut up longitudinally, in strips about two inches wide, one end of these strips being split about five inches, and the button-holes being punched, the suspenders are finished. See plate , fig. .

The other article of improved suspenders or braces is made of woolen felt, in the first stage of its manufacture into felt cloths, before it is sufficiently fulled for the ordinary kind of cloth, or while it is mid-way between the fleece, or bat of wool, and felt. In this state a sheet of gum-elastic is forced into the felt fleece, and while it is passing through the calenders, with the sheet of gum, the fibres of the wool are all drawn one way; consequently, when cut up cross-wise, the felt admits of almost as great tension as the gum, and when cut up, the suspender which is made is evenly and pleasantly elastic the whole length of it, and is finished when the button-holes are cut, as represented figs. 8 and 9.

Before being cut up the goods are perforated. They are beautifully ornamented with the same facility as those before described.

SUSPENDER ENDS.

In the economy and comfort to be derived from gum-elastic suspenders, much depends upon the ends, which are now more than formerly made and put in the market a separate article from the suspender. And what is altogether in favor of these elastic ends is, that they can be attached to the cheapest, as well as to the most expensive and fanciful sorts. However cheap and unyielding the web may be, if only a list or piece of cloth, it will form a suspender sufficiently elastic, when the elastic end is attached; and in case of damage or loss, the end can be replaced at a trifling expense.

The ends represented by figs. 10 and 11, plate xviii., are made of stayed compound; 12 and 13 are made of perforated stayed compound. Those represented by figs. 15 and 16 are made of vulcan-

ized gum-elastic cord, braided over with silk or cotton, the same as those attached to the braces, figs. 1, 2, 3, and 4.

LADIES' ELASTICS.

This, like the gentlemen's suspenders, is also an article, the sale of which is divided among a great variety of kinds. The article represented, plate xviii., fig. 17, is made of various patterns and styles well known to the public. The kind now in common use consists of a ring of elastic compound, covered with silk or ribbon. They may be made by any person from the elastic bands that are sold at the shops, by fastening a ribbon around a bottle, or tumbler, or any other article, either round or square, of the right size, then place the elastic ring over this, and extend another ribbon over them both; stitch the two ribbons together on each side of the ring, and the elastic is complete.

IMPROVED ELASTICS.

Those which are represented in the plate, figs. 18 and 19, are called improved, on account of their durability, and the very small cost at which they may be produced, and because they may be made as fancifully as can be desired with little expense.

The article represented by fig. 2 is made of the same materials as the suspender described, plate xviii,, figs. 8 and 9. The felt is perforated and printed in the piece. When cut up and the clasps attached, the elastics are finished.

Ladies' elastics are yet more cheaply made in another manner, and by many they are preferred to those with clasps, by cementing them in the form of an endless band, in which case the clasp is dispensed with, and they are put on by being slipped over the foot. See plate xviii., figs. 20 and 21.

STAYS, CORSETS, AND BRACES.

Since the invention of the shirred goods, and perforated stayed compound, they have been applied to stays, corsets, and braces, that were formerly in use, besides which they appear to have been the occasion of the invention of a great number of new articles in this line of manufacture. Without pretending to decide upon the particular merits of the different kinds, diagrams are given in plate xviii. of a few of them, the use of which most persons will no doubt understand without further descriptions.

PANTALOON STRAPS.

These were formerly made, both in Europe and America, and were among the first appendages of wearing apparel that were made of the native gum-elastic. They were at first cut from the native gum over-shoe. The vulcanized article has been found much more durable and useful for this purpose; they are made after many devices, many of which are ingenious and deserving of notice on that account.

The common patterns are represented, plate xviii., figs. 22 and 23; button-holes being cut in number 21; 22 is stitched to the pantaloons.

HAT POCKETS

Are a recent invention among hatters, made by shirring the double lining of the hat, near the bottom, with an elastic ring, so that a convenient receptacle is formed for gloves, letters, &c. This appendage, of however doubtful utility, is more safe than carrying the same articles loose in the hat.

HAT COVERS

Are made of tissue, or corded tissue, and are designed as a substitute for the oil silk covers formerly used. When made with a cape as represented, plate xix., fig. , they answer the double purpose of a hat or cap cover, and a storm cape.

HAT AND CAP SPRINGS.

These are made of a gum-elastic cord or tape, either covered or not. Their use is to prevent the hat or cap from blowing off. See plate xix., Chapter XIX.

FOOT HOLDERS.

This is a recent invention,* intended to prevent persons slipping on the ice. It consists of a ring or band, elastic upon the top, and non-elastic in the part which comes underneath the foot. In the upper side of the under part, small pins are inserted to make it hold to the foot, and larger pins are inserted on the bottom to cause it to hold on the ice.

SHOE SPRINGS.

Gum-elastic shoe springs were first applied to shoes, and patented in the United States in 18 .† They were made by stitching cords of native gum between two cloths. Shirred goods were applied to this use as early as 1844. Subsequently, a license was disposed of by the writer to Mr. H. H. Day, and since that time shirred goods have been applied extensively to shoe springs.

* Doct. Charles Stearns, Springfield, Mass.

† Messrs. Dupont and Hyatt, New York.

IMPROVED SHOE SPRINGS.

These are made of napped or embossed stayed compound, perforated as represented in plate , fig. ; or they may be cut as needed, of any size or pattern, from the perforated knit goods, which are made very elastic one way, and non-elastic the other. These springs may be made to match the shoes with which they are worn, by napping in imitation of cloth, or embossing in imitation of any kind of leather. Their chief superiority over the shirred goods shoe springs, consists in cheapness and neatness, and beside, they do not sweat the foot.

There has been some objection made to the shirred spring, on account of its sweating the foot ; this objection does not apply to shoe springs made of perforated stayed goods, or perforated knit goods.

The importance of this small article, the shoe spring, is but just beginning to be appreciated by the public.

Whoever knows by experience the difficulty of teaching a family of children to keep their shoes tied, to say nothing of the neatness and convenience of the article for adults, will hail this as one of the *great* improvements of the age.

A set of these springs will outlast several pairs of shoes, and may be changed from the old to the new. Owing to their cheapness, utility, and durability, their use will probably become as general as that of any other article made of gum-elastic.

See plate , fig. .

VEST SPRINGS.

These have been made of shirred goods, and of different patterns, from elastic webs.

The pattern represented in plate , fig. , made of perforated stayed compound, with a buckle at each end, may be deemed worthy of notice on account of its cheapness and convenience.

GLOVE SPRING.

This is a very useful little article, made of braided gum-elastic cord. It had for some years been made in Europe, previously to the discovery of vulcanized gum-elastic.

CHAPTER XXVI.

WEARING APPAREL.*

Wearing apparel. Observations on water-proof wearing apparel. Coats and capes. Ponchos. Cape and hood. Leggins. Sleeves. Overalls. Cartmen's frocks. Storm collar and cape. Firemen's capes. Fording dresses. Full fording dresses. Baptizing dresses. Caps. Storm caps. Firemen's caps. Neck stocks. Aprons. Nurses' aprons. Washer-women's aprons. Brick-maker's aprons. Mechanics' aprons. Children's aprons. Dissecting aprons. Impervious gloves and mittens. Bathing and flesh gloves and mittens. Dissecting gloves. Boxing gloves. Pervious gloves and mittens. Shoes. Pervious overshoes. Congress shoes and gaiters. Buffalo shoes. Ladies' boots and gaiters. Men's boots and gaiters. Sporting boots. Jack boots. Moccassins. Invalids' shoes. Hotel and house slippers. Insoles. Shoe soles. Life-preserving apparel. Firemen's caps.

In consequence of the recent invention of the perforated fabrics and their contemplated application to many kinds of wearing apparel, it is thought necessary to notice briefly some of the different articles of wearing apparel, under the separate heads of pervious and impervious articles, because the same articles, (although worn in the same way,) are in some cases worn for different purposes, and are often made of different fabrics.

It is obvious that the napped goods are best adapted to cold climates, and the perforated and porous fabrics only are suitable for pervious wearing apparel. Plated fabrics of cotton, linen, and woolen, as well as the fibrous fabrics, vellum, tissue, and felt, either plain, napped, or embossed, and also drapery, are used respectively as materials for water-proof wearing apparel, according to the strength required for the garment, the climate in which it is worn, or the fancy of the wearer. In the following chapter, the various articles are described as made of the different fabrics, in accordance with past experience, and the best judgment that can now be formed of the adaptation of these fabrics.

* A license for wearing apparel had been disposed of to the Union India Rubber Company for the United States, and the business is carried on extensively by them, both at Naugatuck, Conn., and at Harlem, N. Y.

OBSERVATIONS ON WATER-PROOF WEARING APPAREL.

Articles of water-proof gum-elastic wearing apparel are liable to one serious objection, which is, that it confines perspiration; therefore articles of water-proof wearing apparel are only suited to certain occupations, or special occasions, and should always be used with caution.

It is unreasonable to expect a thing to be, at the same time, both pervious and impervious to air and water. The shoe, or garment, being water and air-tight, confines the perspiration of course, and this is not caused by any peculiar property of gum-elastic. Articles of this kind are not intended, and are not suitable to be worn constantly. To use them in this manner would be dangerous to health. Yet, when worn to avoid exposure to rain and snow, they are found invaluable. When intended as a protection against cold, they should be either napped, lined, or worn over other garments. A simple gum-elastic glove worn next the hand will make it cold, but worn loosely over another light glove will be very comfortable. With the laboring classes it is becoming quite common to wear, instead of a leather shoe, what is called the buskin or lined gum-elastic shoes for economy as well as comfort. This is certainly better than to wear leaky or bad leather shoes; but it would be better to avoid wearing them, if possible, in the house. Those who will do so, should have two pairs, which, in the end, will be no more expensive, and changing them will give time for the lining, which has been charged with perspiration, to become dry. With regard to suspenders, elastics, military stocks, or even a vest pattern, or any article that does not come in contact with the person, the idea that prevails with some persons, that they cause perspiration, or are uncomfortably warm, is chiefly imaginary. A military hat or cap is no more objectionable on this account than any other hat or cap, which is made water and air-tight with other gums in the usual manner. In other words, there is no

inherent quality in the gum to cause perspiration more than in other kinds of gum, or more than in fabrics made water-proof with oil. It not unfrequently happens that the purchaser of a coat will return with it, protesting that it leaks, after having labored hard with it, on, in moderate weather. The same thing happens with sportsmen in regard to the boots of this manufacture; nor can they be convinced, until, upon filling them with water, they become satisfied that water cannot get out, and, therefore, that it cannot get in. As it sometimes happens, the article may leak from being badly manufactured, or from its being damaged; the above is therefore always a proper test for ascertaining the facts in the case.

The foregoing remarks apply to water-proof gum-elastic wearing apparel only. Gum-elastic has heretofore been valued for wearing apparel, chiefly, on account of its water-proof quality. It has been taken for granted that no improvement could be made in ordinary wearing apparel with it, and that none was desirable; but whoever considers the expense of time, labor, and money requisite for persons, especially for the laboring classes, to be at all times neatly and comfortably clad, must admit that if any new material could be substituted, which combines durability and neatness with facility of being cleansed, it would add greatly to the comfort and welfare of mankind. It is confidently believed that this desirable object will be attained by the use of the porous and napped gum-elastic fabrics for ordinary wearing apparel.

COATS AND CAPES

These are made of coated cloths or felt. They are made the most completely water-proof at the factories of the licensees,* but they are sometimes made up with the needle from the fabrics obtained in the market, and are made nearly or quite water-proof, when welted in the manner described, page . The

* Union Company, both at Harlem, New York, and at Naugatuck, Conn.

articles of this sort, heretofore made of coated cloths at the factories, are so well known throughout the United States, that a particular description or recommendation of them is unnecessary.

It may here be remarked, as has been done elsewhere, that they should not be worn to exercise much in; and they are most valuable to those persons, such as coachmen, sailors, and teamsters, who have occasion to sit or stand when exposed to storms, or who travel in severely cold weather.

PONCHOS

Are cut after the Spanish pattern, which is so much worn in Mexico, and other countries where the method of travelling is mostly on horseback. The Spanish poncho is generally made of heavy woolen stuffs, an opening being cut in the middle for putting it on, over the head.

The articles here described are made of corded and napped gum-elastic, vellum, plated and napped cloths, or felt, of the above pattern, which is simply an oblong piece of the goods about two yards and a half long, by two yards in breadth. They are a better article than the woolen poncho to sleep on upon the ground, but not so good to sleep under, on account of confining perspiration. (It is believed that this difficulty will be obviated as relates to ponchos, as well as numerous other gum-elastic articles by the manufacture and introduction of the porous fabrics.) They are sometimes made with a pillow in one corner of the blanket, to be inflated at pleasure, as represented plate xix., fig. 1. They are more convenient for riding on horseback than any other form of garment, because the rider has the free use of his arms. They are a better protection from rain than any other, because they can be thrown over the saddle and over the equipments, both before and behind the saddle, and will carry the water off; whereas, in the case of a coat or cape, the water is only carried directly under the seat. When worn with the sleeves and leggins, rep-

resented in plate xix., figs. 2 and 3; and the cap, represented in plate xix., fig. 4; and especially, if the muffler, fig. 5, is added, the rider is most completely equipped and defended against the storm, whether of rain, sleet, or snow; but unless the latter are to be encountered, the muffler is superfluous, as it is too warm to be commonly worn in a warm climate.

The poncho with sleeves, made of vellum, is also a cheap and good protection for milkmen and milkmaids, when engaged in their occupation, or for persons travelling, when exposed to storms.

CAPE AND HOOD.

This article is made of porous vellum, corded vellum, and tissue, or plated cloths for warm climates, and of those which are napped for cold climates.

The hood is a complete appendage for a water-proof garment, and is as well adapted for walking and driving in the rain, as the poncho is for riding on horseback. This form of garment is a very useful one for ladies', as well as for gentlemen's wear.

LEGGINS.

The short leggins, represented in plate xix., by figs. 6 and 7, are best made of vellum, and are used for walking, or riding on horseback, in muddy travelling. The long leggins are represented by figs. 6 and 7. Fig. 6 is fastened by being shirred or corrugated, with an elastic band at the top. Fig. 7 is sometimes shirred, and sometimes secured by a strap around the waist. Fig. 8 is a long leggin, sometimes made of vellum, shirred the whole length by a number of elastic bands, for the same use as figs. 6 and 7; but it is more commonly made of flannel, which is not coated with gum-elastic, and shirred with elastic bands, by means of the needle. This article is designed only to be worn

in the cold and snow, for which purpose it cannot be too highly recommended, as most comfortable and convenient.

SLEEVES.

The long sleeve represented in plate xix., fig. 9, is made of napped and corded vellum, or plated fabrics, and is designed to be worn with the poncho, as described on page . The short sleeve, represented by fig. 10, is made of perforated vellum, or drapery, and is intended to be worn by misses, as a substitute for that which has sometimes been made of morocco, or other material, as a protection for the dress.

OVERALLS.

Gum-elastic corded vellum or plated cloth is best suited for this article, they answer a good purpose for sailors standing on watch, or for the driver, in stormy weather; but they are too warm to be worn much by persons while laboring. In the former case they are undoubtedly conducive to health, but for ordinary wear they should be avoided.

CARTMEN'S FROCKS

Have hitherto been made of coated cloths, after the pattern represented in plate xix., fig. 11. But they have commonly been found too warm. It is a desirable pattern of garment for coachmen as well as cartmen, answering better to wear without leggins than other patterns of coats, although other patterns are usually preferred when worn with leggins. It is believed that when made of porous fabrics it will be found sufficiently waterproof to protect the wearer from wet, and at the same time not too warm.

STORM COLLAR AND CAPE.

This is made of napped drapery or vellum, as represented in plate , figs. 12, 13 and 14. This article, being napped with cotton or wool on the inside, will be found comfortable in a cold storm, affording the neck a complete protection from the rain or snow, a comfort which it is otherwise very difficult to obtain; for, as most travellers know, it is no easy thing to keep out a driving storm by any ordinary apparel. Fig. 12 represents the article as used for a cape or muffler. In fig. 13 the collar is drawn up by the lacing to be used as a cap, and is readily shaped by pressing down the top, as in fig. 14, into a travelling cap.

FIREMEN'S CAPES

Are made of corded vellum, plated cloths, or gum-elastic felt. The fabrics are well adapted for this use on account of their water-proof quality, and also for another reason. Although the vulcanized fabrics burn fiercely when ignited, they do not catch fire so readily as most other fabrics. These capes may be made more comfortable by being made of porous fabrics except the parts about the shoulders; they will then be sufficiently water-proof to protect the wearer from wet.

FORDING DRESSES

Are made of plated cloths, or corded vellum, being in the form of pantaloons with boots attached, and a large tube surrounding the top, which is inflated with air. They are used for fording rivers, and by the aid of a cord to pull the dress back across the stream, a party of any number may cross a river with one dress. See plate , fig. .

FULL FORDING DRESS.

This is a similar article to that described, plate , fig. differing from it only in the upper part by the addition of sleeves, gloves, &c., so as to cover the whole person. Being drawn closely about the neck, a man may ford a stream without removing his garments.

While wearing under the sheet of water at Niagara Falls one of the open, uncouth over dresses of oil cloth, that are afforded visitors at Niagara, at the price of half a crown, the writer imagined that the public might be better accommodated with a dress, such as the one here described, represented by fig. , plate .

BAPTIZING DRESSES.

These are made of plated cloths or corded vellum. They have been found useful, and have been highly approved of by Baptist clergymen, who are obliged to stand a long time in water in cold weather. They are made similar to fishing pants, except that they are cut higher in the waist.

The full fording dress, described on page , either with or without the life-preserver, is also well adapted to this use.

CAPS

Are made either at the factories or with the needle, as caps of other materials are made. Gum-elastic, vellum, and felt, and also the same fabrics when napped and perforated, or embossed in imitation of morocco, are suitable for caps, according to the climate and service for which they are intended.

A suggestion may here be made as to the advantage of making

these as well as other kinds of caps and hats, partly of pervious, and, in part, of the water-proof fabrics, by which they may be made cool and yet water-proof. See plate fig. .

STORM CAPS.

In general, storm caps are made of the same materials as those already described, with the addition of a storm cape, made of corded tissue or vellum for warm climates, and of corded napped tissue, vellum, or plated fabrics, for cold climates.

This cap and cape cannot be too highly recommended to be worn in stormy weather, or when riding with the neck exposed to a draft of air. The cape, when not needed, is turned inside the cap.

FIREMEN'S CAPS

Are made, both with and without capes, as represented, plate xix., figs. 15 and 16. Bands of iron pass transversely over and around the top of the cap. The use of these is to protect the head from falling timbers. The materials of which these caps are made, as well as the method of their manufacture, are much the same as those used for military caps. For a more particular description of which, see Chapter X.

NECK STOCKS.

These are made of perforated felt or non-elastic compound. They are vulcanized and shaped upon forms, so that they will ever after retain their exact shape. They are afterward lined with the needle with any suitable material. For soldiers, or persons who are exposed to storms, it is believed they will form a very useful covering for the neck.

APRONS.

A great variety of aprons are made of the different fabrics, which answer very useful purposes.

In the early manufacture of gum-elastic in the United States, this branch of business, particularly that of ladies' and nurses' aprons, was carried on very extensively, and large quantities of them were made and sold by the Roxbury, as well as other India Rubber companies; so that for one or two years the operations of a number of extensive manufacturers were almost wholly confined to this article. Unfortunately for the manufacturers as well as the public, the aprons that were then made, were almost or quite valueless, and the disappointment was such, that since that time aprons have not been manufactured and put in the market as articles of merchandise, although India rubber piece goods are cut and worn for that purpose. There is little question but when the manufacture is again attempted, and ladies' aprons are made from the fibrous, and porous fibrous fabrics, they will be found as economical and useful as ever was anticipated.

NURSES' APRONS

Are made of plated fabrics and corded vellum, or tissue.

WASHERWOMEN'S APRONS

Are made of plated cloths and corded vellum.

BRICKMAKERS' APRONS

Are made of heavy porous fabrics, or vegetable leather, perforated.

MECHANICS' APRONS

Are made of perforated felt or vegetable leather; when made of the water-proof fabrics they have been found too warm.

CHILDRENS' APRONS.

Corded tissue and vellum, plated muslin, and perforated vellum, are in general best suited for infants' bibs and childrens' aprons.

DISSECTING APRONS

Are made of corded perforated vellum, or plated fabrics, with sleeves and gloves attached. See Chapter VII., Medical and Surgical.

IMPERVIOUS GLOVES AND MITTENS

Are made most commonly of knit goods and napped elastic compound. When made of elastic compound they are constructed in a peculiar manner, with non-elastic stays upon the seams, in order that they may be conveniently drawn upon the hand. They are designed to be worn over other gloves and mittens, and to be used in various departments of labor and occupations, where those engaged in them are obliged to have their hands in liquids that are injurious. Hatters, chemists, dyers, and numerous other tradesmen, who have to make use of strong acids and alkalies, will find them useful. For housewives and servants, who handle coal and ice, and for washing, especially when the hands are dipped alternately in hot and cold water, or when they are chapped, they will be found very valuable.

When these articles are worn over other gloves they are not only comfortable and warm, but they are a great protection to other gloves, keeping them from being injured by wet. They are not intended to be worn next the hand, except in cases where it is inconvenient to wear an under glove. Fine light gloves and mittens of gum-elastic tissue and drapery, are also much approved for bleaching ladies' hands, and healing those that are chapped.

BATHING AND FLESH GLOVES AND MITTENS.

See Chapter XIII, Bathing Apparatus.

DISSECTING GLOVES.

See Chapter , Medical and Surgical.

BOXING GLOVES.

See Chapter , Sporting.

PERVIOUS GLOVES AND MITTENS.

Specimens of this article have recently been made from perforated felt and perforated elastic compound, which give assurance, that ere long, gloves and mittens will be made for ordinary wear, which will answer well as substitutes for gloves and mittens made of buckskin, kid, wool, and other stuffs; and that the heavier kinds, at least, will be made pervious to air and impervious to water.

SHOES.

About thirty years since, the first few pairs of native gum-elastic shoes, or what might more properly be called India rubber bottles, with openings in the sides, were imported into Boston.

At that time their uncouth and clumsy shapes, added to their weight, was a great hinderance to their introduction; notwithstanding which, their importation continued to increase, as they were gradually improved, until 1840, previous to which time more than half a million pairs were imported in one year.

The first vulcanized gum-elastic shoe was made by the inventor in 1840, but owing to the difficulty of operating the heating process at that time, and the embarrassments of the writer, this manufacture was not fairly started until 1843, or much noticed in any way until 1844.

In 1845, a successful shoe manufacture was put in operation at Hamden, Connecticut,* and another at Naugatuck.† As the manufacture of these shoes was improved, they came rapidly into favor with the public, and the demand has increased, so that, at the present time, fifteen thousand pairs per day are manufactured by the licensees of the inventor.

For several years past the increase of this manufacture has more than doubled each year, which will probably be the lowest estimate which can be made of the increase of the manufacture for some years to come; since, in addition to the real utility and durability of these goods, the manufacturers have attained a perfection of finish, and a style of execution, which is hardly surpassed in any branch of manufacture, either in this or any other country; and the demand for them is not only becoming general throughout the United States, but they are being exported largely to England, and are also being introduced into many other foreign countries. They have become so common in the United States, and their qualities are so well known, that any remarks

* By Mr. L. Candee.

† By Mr. William Deforest.

concerning them are, perhaps, unnecessary. They are, to many persons, an article of absolute necessity; and their great economy is a great temptation, especially for the laboring classes, to wear them constantly. Some persons may do this with impunity, especially if they are changed often; but in general, on account of their confining perspiration, they may be considered injurious to health, if worn constantly. They are only suitable to be worn out of doors in wet or muddy walking. The foregoing remarks are applicable to this branch of manufacture as it has been, and as it now exists; but in consequence of the improvements which are made in the fabrics by perforating or making them porous, it is presumed that gum-elastic shoes will, ere long, be made, which may be worn constantly, with even more satisfaction than leather shoes. Specimens of perforated and porous gum-elastic shoes have recently been made, that warrant the conclusion that the gum, with the high finish that is given to these shoes, is so far a repellent of water, that, when they are of an ordinary thickness, water will not penetrate them, unless under pressure; and it is certain that they are equally comfortable, or more so, than shoes made of cloth or leather, so far as relates to the upper portions of them.

The soles, when made of India rubber, cemented in the usual way, will, in some degree, cause the soles of the feet to perspire. This may be obviated in a great measure by an inner sole of another material, and completely removed by cementing a stay around the edge of the upper, and stitching a leather sole to it, in the same way as leather shoes. By these means it is expected that gum-elastic will answer not only the present use for over-shoes, but that it may be made a porous vegetable leather; and so far, at least, as shoes are concerned, a substitute for animal leather for ordinary wear.

If the writer is correct in these conclusions, the future usefulness and extent of this branch of gum-elastic manufacture can hardly, at the present day, be estimated. The saving of expense certainly cannot, at present, be estimated. Even now, the cost of shoes of gum-elastic or vegetable leather, is much less than

those made of animal leather; and the expense of manufacturing some kinds, when the shoes or boots are cemented, is as ten to one in favor of gum-elastic, so that when the channels of supply are fairly opened for obtaining the raw material in the abundance in which nature yields it, what is anticipated now can hardly fail to be realized.

Among the numerous kinds of gum-elastic boots and shoes that are being made, the following may be noticed, most of them because of some peculiarity in their construction, on which account diagrams of some of them are given.

PERVIOUS OVER-SHOES.

The public have become so well acquainted with the impervious vulcanized over-shoes, that any description of the various styles, or comments upon them, more than have before been made, may be superfluous. The perforated over-shoes, which are here alluded to, are made whole, and without perforations, like other over-shoes, for *about half an inch* up the sides, the other parts of the upper being perforated, as represented plate xx., fig. 1.

CONGRESS SHOES AND GAITERS.

This is a term which has been applied to boots and shoes of various kinds, which have the gussets or springs inserted, which are described, page

These might, with more propriety, have been called the people's boots and shoes, for the reason that, in all probability, they will go into general use among all classes. While the article was made with the springs of shirred goods, they were much approved, notwithstanding these springs were too close for hot weather. Since the introduction of the perforated spring, no objection exists to this improvement. It is found to answer the

purpose of fastening gaiters and shoes so much better than any shoe-string, clasp, or lacing, that has heretofore been used, that no comparison can fairly be made between the old and new method of fastening shoes on the feet. See plate xx., fig. 2.

BUFFALO SHOES.

Shoes made of buffalo hides, with the fur inside, have been very much worn in the northern and western states, where furs are abundant, and where an article of this kind is needed on account of the coldness of the climate; but they are oftentimes uncomfortably warm, and do not answer in snow-water or wet weather. When these shoes are made of buffalo hides, covered with gum-elastic, they are much more durable and comfortable if the upper parts of the shoe are perforated, so as to be pervious to air and impervious to water, as represented, plate xx., fig. 3.

LADIES' BOOTS AND GAITERS.

The upper part of these are made of porous fabrics, or felt loosely cut. No article of the shoe kind is more useful than this for ladies and children to wear in the snow, or in muddy walking, or when dew is on the grass. As a preservative of health they are invaluable. See plate xxi., figs. 4 and 5.

MEN'S BOOTS AND GAITERS.

Vulcanized gum-elastic boots have commonly been made upon a knit fabric; gum-elastic felt is also a suitable material for this purpose, when the tops are perforated, as represented by figs. 6 and 7. They are comfortable to be worn at all times. They are made of both the above materials, without perforating, for wear-

ing in water. Another article has been made to considerable extent, by covering a woolen felt boot, formed whole, like a hat body, with a sheet of elastic compound upon the outside. These boots have been highly approved, to be worn occasionally for a day in severe cold or stormy weather, as, in so short a time, the felt does not saturate with perspiration, so as to make them uncomfortable. When thus worn, or for standing, or wading in water or snow-water in cold climates, they are unquestionably more comfortable than any other boot; but it is the height of imprudence to wear them constantly for days in succession.

SPORTING BOOTS.

These are made of the same materials as the gum-elastic boots before described; the tops are made either of felt or plated cloth. They are fastened by a belt around the waist, and worn for wading in water, or for marsh shooting, being made high, as represented in plate xxi., fig. 8.

They do not always answer the expectation of the wearer, being too warm for active exercise. They are as uncomfortable for the feet, when wet with perspiration, as when wet with water. They may be worn with great satisfaction by any one standing in water, or wading in marshy ground, either for fishing or shooting, when the wearer does not exercise so as to perspire freely.

JACK BOOTS.

This article, which has heretofore been made of hard leather, may be advantageously made of perforated felt, or vegetable leather. See plate xxi., fig. 9.

MOCCASINS.

It is well known that the buckskin moccasin, which is so much prized for wearing in cold weather, is much injured by being wet. They may be much improved by being covered on the bottom and sides with elastic compound. See plate xxi., fig. 10.

INVALIDS' SHOES

Are manufactured of perforated gum-elastic felt, and porous elastic knit goods, with an insole of perforated sponge fabric, as represented in plate xxi., fig. 11. Besides answering the common purpose of a leather shoe, this article will be found most comfortable for those who are afflicted with lameness, especially when the soles are made of gum-elastic sponge.

HOTEL AND HOUSE SLIPPERS.

These are made from the perforated gum-elastic fabrics, with leather soles, by stitching like other shoes. These slippers are not only pleasant and comfortable in-doors, but they may also be worn out of doors, or in the wet, with impunity. Numerous other kinds of perforated shoes for ordinary wear, as a substitute for shoes of cloth and animal leather, might be noticed with equal propriety; but it is presumed that their advantages will be sufficiently obvious from the descriptions already given, and the diagrams, plate xxi., fig. 12.

INSOLES.

Insoles for leather shoes may be formed of sheets of perforated gum-elastic sponge, as represented in plate xxi., fig. 13, which are so very soft, elastic, and pleasant to the feet. For the lame, were it not for the objection of sweating, these articles might be highly recommended. The objections are, in part, removed by perforating, and afterwards covering them with flannel or other woven cloths.

SHOE SOLES.

Within a few years past a method has been adopted in some parts of the United States, of cementing an outer sole of vulcanized elastic compound upon leather boots and shoes, both when they are new, and after the leather soles are worn off.

These articles have given entire satisfaction to the wearer, both on account of their economy, in causing them to wear much longer than they otherwise would, and because they answer, in part, the purposes of an India rubber shoe in keeping the feet dry without causing them to perspire.

An article of this kind has been recently invented,* which can be conveniently put on and off, as represented in plate xxi., fig. 14. The strap of this sole is made of elastic compound. Although it is as yet quite new and untried, it may be considered a real improvement, and another acquisition for the comfortable protection of the feet. See plate .†

LIFE-PRESERVING APPAREL.

A number of these articles are represented, plate xxi. The fabrics from which they are manufactured, viz., the air-work and

* By Doct. Charles Stearns, Springfield, Mass. † Since introduced, and found highly useful.

the quilted fabrics, are described, Vol. I., Chap. X. The uses to which they may be applied, and their utility as life-preservers, are alluded to in the description of one of them, fig. 4, as a poncho, or cape bed, in Chapter . The style of work is durable, and, arranged as there described, is perfectly safe as a life-preserver, and also useful as a mattress, bed, or cushion; but considering its bulk, how far it may be applied or made practically useful for garments, in comparison with other things that are lighter and more convenient as garments, is a question.

FIREMEN'S CAPS

Are manufactured by the combination of caoutchouc whalebone and vegetable leather, much in the same manner as the military caps, described in Chapter . This cap is made so as to unite all the properties that are desired in firemen's caps, being so constructed as to ward off accidents, without being too heavy or unyielding. See plate , fig.

CHAPTER XXVII.

BATHING APPARATUS.

Bath tubs. Portable bath tubs. Child's bath tub. Foot baths. Portable foot baths. Bathing mats. Bathing and flesh gloves. Bathing and flesh mittens. Bathing pantaloons. Shower baths. Hand shower baths. Sponge bags. Bath tub straps. Bathing caps.

In this hydropathic age, when the public mind is awake to every thing that relates to bathing, labored argument is not necessary to prove that gum-elastic is useful for such purposes; and it is presumed that a brief description of the various articles of this kind that have been made of it, together with the drawings in the plate, are all that is required to give the reader a correct idea of their adaptations.

BATH TUBS.

Stationary tubs are made of caoutchouc board or whalebone, on account of cheapness, and for the purpose of giving medicated acid baths, as the gum is not injured by acids, like metal or wood.

PORTABLE BATH TUBS.

These may be, and have been constructed in various ways, among which two kinds have been selected for description, which appear best adapted for this use, as represented in the diagrams, plate , figs. 1 and 2.

Fig. 1 represents the article made of corded and barred plated fabrics, constructed of the common form of bath tubs, of any size required, with a strong hose about three inches in diameter, of the same material, running upon each side, the length of the tub, through which bars may be slipped to support it.

Fig. 2 is another form of bath tub, which is made with a wooden or iron hoop around the top, and movable bars or supports, which are hinged at the bottom with elastic compound, which gives way enough to allow the supports to be slipped into sockets at the top of the tub, or they may have non-elastic hinges at the bottom, and be otherwise hinged or fastened at the top. Either of these kinds, when not in use, occupy a very small space, which is often a great consideration for camp and for ship's use.

CHILD'S BATH TUB.

The bathing mat, with a large tube, is sometimes used as a child's bath tub. The tub may also be made by nailing a square piece of plated canvas upon a frame or horse, in the manner represented in the plate , fig. , or they may be made of a small size, in the same way as the portable bath tubs already described.

FOOT BATHS

Are made of gum-elastic whalebone board, as represented in plate, figs. 1 and 2. They have an advantage over earthen or metal baths on account of their lightness, and are not liable to be broken or bent.

PORTABLE FOOT BATHS.

These are made of strong plated canvas, as represented in the plate, figs. 6 and 7, with the rims and braces arranged in the same manner as in the portable bath tubs already described, and they may, like them, be packed in a small compass for transportation.

BATHING MATS.

These are made of gum-elastic vellum, plated cloth, or plated muslin, from three to six feet square ; and are also made round, from three to five feet in diameter, as represented in plate , figs. 8, 9 and 10. The cheapest article of the kind, fig. 8, is made with a cord of elastic sponge or cotton rope, cemented in around the edge, to prevent the water from running off the mat when in use. Figs. 9 and 10 represent an improved bathing mat, made with a border inflated with air around the edge, instead of the cord as above described. This border is inflated with the self-acting valve tube, described page . The advantage gained by this improvement is this, when the border is collapsed it is much the most portable, and it therefore admits of a much larger border being used, than can be obtained with the cheaper article made with a cord. Both these articles will be found very useful in families for bathing. They are also a great convenience and comfort for the same purpose to persons travelling, particularly when the hand shower bath is used. When the tubes are made large enough, or when one is placed above another, as represented by fig. 11, they may be made to answer all the purposes of the bath tub, especially for children.

BATHING AND FLESH GLOVES.

These are made of knit goods or elastic compound, with a sheet of elastic tufted sponge cemented to the face of the glove. They answer the common purposes of a flesh brush, and are made superior to bristle brushes for bathing, as they are not softened by being saturated with water. See plate , fig. 12.

BATHING AND FLESH MITTENS.

This article is very similar to the glove above described, except that it answers the purpose of a clothes brush as well as other uses, better than the glove, and they are somewhat differently made; the inner part of the mitten being made of a sheet of the sponge, instead of being lined or veneered with it like the glove. See plate , fig. 13.

BATHING PANTALOONS.

These are made of vellum or plated fabrics. They are evidently better adapted for the purpose of bathing than the clothes which are commonly used at watering-places and at public bath houses, and are the more convenient for being gathered at the top and bottom, being shirred with an elastic cord. See plate , fig. 14.

SHOWER BATHS.

The curtains of a variety of shower baths, both portable and stationary, may be made of gum-elastic tissue and vellum, among which may be noticed those represented by figs. 21, 22, and

23. These fabrics may be recommended for this use on account of their cheapness and water-proof quality.

HAND SHOWER BATH.

This is a convenient article, both for families and for travellers, and is designed to be used generally with the bathing mat. It is made of gum-elastic vellum or elastic compound, distended by a series of hoops, diminishing in size one above the other, so that when collapsed, it shuts in a very small space, and is quite portable.

The article is filled with water by suction, through the sieve at the bottom, which is made of perforated caoutchouc whalebone or whalebone board. See plate , fig. 17.

SPONGE BAGS.

These are made of vellum, tissue, and drapery. They are much cheaper, if not far preferable, to those made of oil silk. They are the more convenient on account of the mouth being closed by being shirred with an elastic cord, and may be recommended as a useful article to travellers, for carrying sponges.

BATH TUB STRAPS.

This is a strap of elastic compound stayed goods, and though a small article, may be recommended as a substitute for the cloth strap or webbing, heretofore used at the head of bath tubs, on account of its cleanliness, elasticity, and water-proof quality.

BATHING CAPS

Are made of drapery or tissue. These fabrics are very suitable, and highly approved of for this purpose; the drapery, on account of its elasticity, and both on account of their waterproof quality and cheapness. They are shirred around the edge with an elastic cord. See plate , figs. 15 and 16.

CHAPTER XXVIII.

TRAVELLING APPARATUS.

Umbrellas and parasols. Trunks. Paper trunks. Hat boxes. Muff boxes. Valises. Band-boxes. Travelling bags. Improved travelling bags. Incompressible bags. Portmanteaus. Saddle-bags. Mail-bags. Horse mail-bags. Bottles. Hot-water bottles. Improved hot-water bottles. Shaving boxes. Dressing boxes. Portable desks. Pocket instands. Expansion trunks and valises.

The advantages to be derived from the use of gum-elastic for travelling apparatus are so obvious, that it may be emphatically said, this is one of its most appropriate uses.

The fabrics are not only suitable substitutes for other materials in the manufacture of many kinds of travelling apparatus, which have been in common use, but they have also given rise to improvements in their construction, and many things have been invented from them, which add to the convenience and comfort of travelling, and what is of more consequence, to the safety both of person and property. Descriptions of an assortment of these inventions will be found in this and the following chapter.

UMBRELLAS AND PARASOLS.

See Chapter .

TRUNKS.

Common wooden trunks may be rendered water-proof by covering them with gum-elastic materials, of different kinds, and a further improvement may be suggested in the use of a fabric, with gum-elastic nails or studs of non-elastic compound or packing. In either case, short wood screws may be inserted through the studs into the wood part of the trunk. This will obviate, in a great measure, the common liability of trunks to chafe and damage. This method is certainly preferable to the common one of loading trunks with heavy metal nails, which give little more than a *show* of strength and protection to the trunk, while at the same time they serve to damage every thing else with which they come in contact.

PAPER TRUNKS.

The improvements which have, of late years, been made in the manufacture of pasteboard, have rendered it suitable for many substantial uses. It is, in many cases, equally or more substantial than wood when protected from dampness. Its being liable to be damaged by water, and being so difficult to nail or fasten together by any means heretofore known, has undoubtedly prevented its being used for a great variety of purposes for which it might otherwise be suitable.

A plan is adopted in the manufacture of these trunks, which might be applied to other things made of pasteboard. They are cemented together with gum-elastic bindings, and afterwards covered with the gum-elastic fabric, being strengthened with bands and braces of tin, sheet-iron, or other suitable supports covered with the same material.

It is believed that trunks of this description will be found more durable than those which have commonly been made of wood.

HAT BOXES.

Common pasteboard hat boxes are made water-proof and very durable, when constructed upon the plan of the paper trunks, before described.

MUFF BOXES.

See Chapter VII.

VALISES.

The same improvements that have been suggested for band-boxes and trunks are applicable to valises, when they are made either of wood or of pasteboard.

BAND-BOXES.

The common pasteboard box is much improved and rendered durable by covering with gum-elastic tissue or vellum. These fabrics may be put on in the usual way with glue or flour paste. The paste being protected from dampness by the coating of gum, it is not necessary to use a more expensive cement. If they are strengthened by a hoop of rattan or tin, covered with the fabric, and placed around the edge of the lid, and also around the rim of the box, as represented, plate , fig. , they are rendered much more durable. Paper boxes, constructed in this way, have been found to last for years. They may be exposed outside in travelling like trunks, and do not require that extraordinary care of being carried inside the vehicle, which has always made paper boxes so annoying to travellers.

The first cost of boxes made in the way here described, is something more than that of paper boxes in common use, but in

the end they will be far the cheapest, to say nothing of what is gained in safety.

TRAVELLING BAGS.

Numerous kinds of these are manufactured of different gum-elastic fabrics. The plated fabrics may be recommended as most suitable in general for the common kinds. They may be made up with the needle, and secured by different kinds of fastenings, like other bags. That represented by plate , fig. , has an apron or mouth attached to the top, which may be dropped within the bag or used out of it, so as to increase the size very much.

IMPROVED TRAVELLING BAGS.

This bag is made of gum-elastic materials, and differs from other kinds only in the method of fastening it. It is closed by a slide made either of gum-elastic whalebone or metal. This slide is simply a plain hollow tube, either round or square, with a handle in the middle, and a cut the whole length, into which the mouth of the bag is slipped. This tube is equally well adapted for traveling bags made of other materials besides gum-elastic; it will be found one of the most simple and convenient fastenings, and may be made quite secure by a padlock at the end. See plate , figs.

INCOMPRESSIBLE BAGS.

The incompressible bag, which is designed to pack in the smallest compass when collapsed, is made of gum-elastic plated fabrics, as represented by plate , fig. . They are inflated by means of the valve tube described on page , and their inflation prevents their contents being damaged by pressure. They are well adapted to carry light articles, such as

caps, ruffles, &c.; also for a life-preserver, being made quite impervious to air and water.

The same form of bag, when made of heavier materials and vulcanized upon a block or last, will keep its shape so as not to require inflating with the tube.

A convenient form of incompressible bag is made as represented by fig. , having the body of a trunk or box united with the upper part or mouth of a bag. A similar article is made with a box which shuts or folds like an accordion. See plate , fig. .

PORTMANTEAUS.

Portmanteaus are manufactured of perforated gum-elastic fabrics, in combination with those which are not perforated, as represented by plate , fig. .

SADDLE BAGS.

These are manufactured of the same material as the portmanteaus, and may be recommended on account of their water-proof qualities and safety in fording rivers, particularly when they are made water-tight at the mouth. See plate , fig. .

MAIL-BAGS.

If there is any one purpose for which it is desirable to substitute gum-elastic for leather, on account of its water-proof quality, it is for mail-bags. The value of their contents, and their exposure to damage and loss by water, being generally known and often commented upon, led many persons, at a very early period, to suggest to the writer that this would be a useful application of gum-elastic.

On these accounts the first premature attempts to make mail-bags, were made before the vulcanizing process was at all understood or rendered practicable to any extent.

The unsuccessful attempt by the inventor to manufacture mail-bags of gum-elastic, previous to the discovery of the vulcanizing process, has been noticed in the first volume of this work; this was followed by another premature attempt of the licensees to make them of vulcanized coated canvas. These, although answering a tolerable purpose, did not give satisfaction, owing to the weight of the article, and the gum peeling from the canvas. This last obstacle to the use of these fabrics as a substitute for leather, has frequently been remarked upon, and also the manner in which the difficulty is removed by the invention of the fibrous fabrics, felt and vegetable leather. Since the invention of these fabrics, specimens of mail-bags have been made, which, in the judgment of those who have seen them, cannot fail to answer the purpose for which they are made. They are constructed of corded and barred fibrous and plated fabrics, fastened in the usual way with the chain, or with jaws, like the ships' letter bags. See Chapter , fig.

HORSE MAIL-BAGS.

Horse mail-bags are used for conveying mails on horseback, in parts of the country where it is impossible or difficult to convey them in coaches or wagons. They are, therefore, more exposed than other mail-bags to be lost or injured by water in fording rivers. A gum-elastic bag of this sort has been constructed of gum-elastic fabrics, in the form of the common portmanteau; and when the mouth is closed with a water and air-proof fastening, as represented plate , fig. , they may be made to answer the purposes of a life-preserver, both for the horse and rider, in fording rivers.

BOTTLES.

Several kinds of gum-elastic and covered bottles have been noticed under their respective heads, Chapters

Recent improvements, by which the vulcanized fabrics are made more pure and free from odor, render this use of gum-elastic more deserving of special notice. The insertion of the bottle tube, made wholly of gum-elastic, with a valve, and cemented to the bottles, is an additional recent improvement. The cost of canteens, hot-water bottles, and other flexible kinds, may also be much reduced through their manufacture by machinery, after the manner of air-work, described Vol. I., page .

HOT-WATER BOTTLES.

Are manufactured of unvulcanized fabrics, with a large tube of artificial ivory, and India rubber bottle-stopper. They are intended to be used in cases of sickness to give warmth to patients, or for travelling in cold weather, but may also be used for other purposes. These bottles are unquestionably among the most convenient and effectual means of applying warmth to patients in the hospital and sick room, or for the service of those who suffer from coldness of the feet.

IMPROVED HOT-WATER BOTTLES.

Are made of unvulcanized fabrics, like other hot-water bottles, with the addition of a tunnel made of caoutchouc fabric, attached to the neck, in order that they may be filled conveniently on all occasions, without the use of a separate tunnel.

They are also made with partitions, like some kinds of air-work, in order to keep them in the shape desired. Some of the various patterns are represented by figs. , plate .

SHAVING BOXES.

Most persons who use shaving boxes are aware that some improvement is needed in them, especially for travellers. When

made of wood the lids warp, and it is very difficult to keep them on; metal boxes corrode; glass and china are heavy and brittle, and have the same defect as the wood, from the looseness of the lids. Gum-elastic whalebone is recommended for this use, for the reason that it is not injured by hot water, will not warp like wood or corrode like metal, will not break like china or glass, and admits of the box being made water-tight by screwing on the lid.

DRESSING BOXES.

Superior boxes of this sort may be cheaply manufactured from caoutchouc ivory, instead of fine wood, and when it is desired they can be made with a soft surface of artificial gum-elastic upon the ivory, to make them resemble such as have commonly been covered with morocco.

PORTABLE DESKS

Are manufactured upon forms or in moulds of caoutchouc whalebone. On account of the lightness, hardness, and strength of this material, it has the same general recommendations for portable desks, that it has for the shaving and dressing boxes before described.

POCKET INKSTANDS.

A useful and curious pocket inkstand is manufactured of gum-elastic, with a gum-elastic ivory screw stopper and valve. See plate , fig. .

EXPANSION TRUNKS AND VALISES.

Trunks and valises of a pattern which has sometimes been made of leather, are now made of caoutchouc and whalebone board with new facilities, the material retaining its shape much better than leather. The trunk or valise is made in two parts, of about the same depth. That part which forms the top, and is a trifle the larger of the two, shuts over the other, and by being raised or depressed, the size of the trunk is proportioned to its contents. See plate , fig. . These are easily made a life-preserving apparatus when manufactured with a cushion of gum-elastic sponge around the edge of the lid upon the inside, so that when the trunk, valise, or box is reduced to its smallest dimensions, and the edge of the lid shuts against the cushion, it is rendered quite water and air-tight. See plate , fig.

In the application of gum-elastic to traveling apparatus, an improvement is made by a method of marking and numbering the articles, which adds greatly to their security against miscarriage and loss. This, in the present mode of traveling by railway, is no inconsiderable advantage. The impossibility often of getting baggage checked for want of time, renders every precaution necessary.

The improvements consists in manufacturing the article with mottoes and numbers in bas-relief, selecting a different motto for each size of each class of articles, and a different number for each article.

This method of marking adds nothing to the expense of the articles, the mottoes being moulded in the process of vulcanizing, while much is added to their value by being rendered less liable to loss.

CHAPTER XXIX.

LIFE-PRESERVING TRAVELLING APPARATUS.

Life-preserver trunks. Improved life-preserver trunks. Water and air-proof valises. Water and air-proof hat and bonnet boxes. Travelling bags. Life-preserving travelling bags. Double life-preserving travelling bags. Life-preserving expansion trunks and valises.

A variety of articles for the preservation of life have been treated of under the head of Air-work, but the design of the author in this place is to call the attention of the reader to that class of India rubber goods that may be used for different purposes in travelling, as well as for the preservation of life and property.

The defects of life-preservers inflated with air have been noticed in a preceding chapter; the advantages to be derived from the improved construction of different kinds were also noticed, and the inference was drawn that, notwithstanding all their objections, much good might yet be derived from the use of life-preservers inflated with air only, although some of the other kinds described were much to be preferred for safety. Whatever doubts may arise as to the comparative utility of any of the life-preservers before treated of, none need to exist as to the value of those which may be used for travelling purposes at the same time. Articles which are deemed, on the whole, of importance, not only for the purposes of travelling, but also as life-preservers, are here noticed. Notwithstanding it seldom happens that one article can be made to answer perfectly two distinct uses, an exception to this rule is claimed for the whole class of articles described as life-preserving travelling apparatus. Most of them answer two or more useful purposes, without objection.

For ordinary life-preservers there is but occasional use. For trunks, valises, carpet bags, and other travelling apparatus which may be made available as life-preservers, there is constant use. The importance to the public, however, of every improvement, depends upon the comparative cost of the article improved. The cost of most articles of this kind of travelling apparatus is not increased by the improvements suggested, except in the case of paper-boxes; and these are so much improved, that no comparison whatever should be made between them and those that have formerly been in use.

The expense of most of these articles is very much less than that of those heretofore used for the same purposes, and for some of the more expensive articles, the cost is lessened one half. This is the case with the trunk, hat-box, and other travelling apparatus, that are designed as substitutes for those which have heretofore been made of sole leather. The adaptation of these articles to use as life-preservers, does not render them any the less, but rather the more, useful for the purposes of travelling. Various expedients are devised for making them perfectly air-tight, which are cheap, simple, and effectual.

Some effectual means of closing the mouth of bags, for inflating air-work, and also for rendering gum-elastic trunks and boxes water and air-tight, were required in order to make them complete for these purposes, or at all infallible as life-preservers. These means have been effectually provided. The gum-elastic *self-acting valve* tube for inflating life-preservers, buoys, and other air-work; the cushioned clasp and jaws, and also the slide, for securing the mouths of bags, together with the groove and cushion, for rendering boxes and trunks water and air-tight, have been satisfactorily tested, and found unobjectionable for accomplishing the object.

To perfect these, although so simple and effectual when done, has caused much perplexity and great expense to the writer; and it is worthy of remark, by way of illustrating the general applicability of gum-elastic to useful purposes, that this object has only been attained by resorting to the vulcanized fabrics,

sometimes in combination with metal, but in most cases alone. These contrivances are as admirably fitted for closing the apertures of the different articles, as the fabrics are for rendering the body of them water and air-tight. It is important for many reasons that trunks and boxes which are used for containing clothing, should be tight, for standing in the house, as well as on ship board, and should have water-proof and durable covering, for some dwellings even, especially in new settlements, are not water-tight, and articles are exposed to be damaged in them, unless they are kept in trunks or boxes that are water-proof.

It is always desirable that both dust and dampness should be kept out of trunks and boxes that contain wearing apparel, because in travelling, the damage to clothing is often very great from dust, as well as from exposure to the damp salt atmosphere, to say nothing of storms by sea and land. This damage is effectually guarded against by the improvements in travelling apparatus. The exclusion of moths, without the use of articles that are offensive in clothing, such as tobacco and camphor, is another important advantage to be gained by the use of trunks, boxes, and bags of this kind. The incompressible bag is an improvement exactly suited to the rapid travelling of modern times. A very portable and flexible article of this kind answers the purpose instead of heavy trunks, to carry small and light articles, which are exposed to be broken and damaged. It may be used also for a pillow, cushion, or foot-stool, without materially injuring it, or exposing the contents to injury.

The arrangement of these different articles, when used as life-preservers, may be more easily pointed out, and made more apparent in the descriptions of the particular articles.

They may be considered perfectly safe as life-preservers, and although not so easily secured or bound to the person, they may be easily held on to, and easily attached together, to form rafts, or lashed to boats, so as to form life-boats of any wooden boats, although leaky. In order to impress the reader with the idea of the security of these articles, in comparison with those that

are inflated with air, some remarks upon the buoyancy of different articles may here be made.

It is generally supposed, at any rate it is the first impression of most minds, and even of a great portion of those who are well educated, that in order that an article may be sufficiently buoyant to answer the purpose of a life-preserver, it must be inflated with air, and must be so tight that the air cannot escape; whereas if the sides of the article are kept distended, it may be very leaky, and it will yet be a great length of time before it will become unsafe, when otherwise it would collapse and allow the wearer to sink instantly, if the sides were not kept distended by some resistance greater than the pressure of the water without.

The force of these remarks may be illustrated by a barrel with the bung out, or a demijohn with the cork out, both of which it is extremely difficult to sink in the water when they are empty, even when it is intended to do so. In most cases these articles will be quite safe as life-preservers, even if the article is not perfectly tight; in other words, a small leak, that would cause an article inflated with air to collapse and sink immediately, will not affect the safety of these articles in the slightest degree.*

The weight that will be sustained in the water by any of the articles hereafter described, may be certainly known by its cubic measurement, allowing sixty pounds to the cubic foot, and deducting the weight of the article; that is to say, a trunk or valise weighing ten pounds, and measuring two cubic feet, will sustain an extra weight of one hundred and ten pounds in the water.

It is well known that the specific gravity of the human body is less than that of water, and that it will not sink by its own weight, but it requires a buoyant power which is equal, for the average of persons, to about nine pounds. In other words, any article that will keep afloat a lead weight of nine pounds, will sustain a person in such a position in the water that he will be safe from drowning; but to make a more liberal allow-

* See Reports, Chapter , page .

ance, the estimate would be better made at fifteen pounds for each individual; consequently, a person travelling with a trunk measuring three cubic feet, allowing thirty pounds weight for the trunk, would take safely on shore one hundred and fifty pounds weight of gold, or other valuable property.

The proofs, with regard to the facts here stated, are ample, and the arguments should be conclusive; but the most important theories may be well established, and yet remain practically unknown, owing to the difficulty of making that which is clear to the inventor, intelligible to practical operators, and to those who execute the designs of inventors, so that they may safely co-operate with him to produce the thing desired. It is believed, however, that such a difficulty will not long exist on this subject, but that the specimens which have been made by the writer so demonstrate the utility of the articles, that they will, ere long, be brought into general use.

LIFE-PRESERVER TRUNK.

That represented by fig. 1, plate , is a cheap kind of water-proof trunk. The frame or box is made of wood in the usual manner, and covered with gum-elastic vellum or vegetable leather. A groove of about half an inch in width is cut in the wood in the top edge of the trunk. This groove is filled with a gum-elastic sponge cord. The hinge of the trunk is made of gum-elastic stayed fabric, about two inches wide, extending the whole length of the trunk. Elastic buckle straps, such as are described on page , are used instead of leather. When these are drawn tight, the trunk is made impervious to air and water, by means of the gum-elastic sponge cord inserted in the groove.

Another method of making the trunks water and air-tight, is by a cushioned lid, both in the top and bottom of the trunk, as will be easily understood from the plate , figs. 1 and 2.

IMPROVED LIFE-PRESERVER TRUNK.

The method of rendering these trunks water and air-tight, is very similar to that used for the wooden trunk before described. Being made upon an iron frame instead of wood, the cushion is either fastened upon the top of the frame, or secured in a groove as represented, plate , fig. .

The body of the trunk is formed of caoutchouc whalebone or board, wrought and cemented together so as to be as light and strong as possible. This may be considered as one among the most important applications of gum-elastic, on the score of economy as well as utility. The saving of labor when compared with the all-leather trunk, for which they are intended to be substituted, is greater than in most articles of gum-elastic, except shoes and some parts of harness.

A common sized trunk of this sort, measuring three cubic feet, allowing thirty pounds for weight, has buoyancy sufficient to sustain one hundred and fifty pounds of baggage, so that they may serve not only all the purposes of a life-preserver, but at the same time will carry safe a large amount of specie or other valuables. A number of them lashed together will form a safe raft, or if lashed upon the outside of a boat, will make it perfectly safe for a much greater number of persons than it would otherwise carry; and even if the boat is staved or broken, it may be made a perfect life-boat by lashing these trunks in it. This, like the one well known as the all-leather trunk, has the least weight combined with the greatest strength. The expense of the all-leather trunk has been a great hindrance to its general use, but the substitute here proposed, will probably be afforded at a much less expense than that has heretofore been.

WATER- AND AIR-PROOF VALISES.

These do not require description further than has been given of trunks of a larger size, except that being smaller they may be

made without iron frames, or may be made in moulds like hollow-ware. When made wholly of gum-elastic materials, being water and air-tight, they are equally useful in proportion to their size for life-preservers, and are more readily kept at hand.

WATER- AND AIR-PROOF HAT AND BONNET BOXES.

The improvements which have been suggested for the manufacture of trunks and valises, are equally applicable to hat and bonnet boxes, and the same advantages may be derived from their use in the same way. For no article is a cheap and substantial water-proof substance, instead of paper, more needed than for band-boxes. For this purpose India rubber whalebone or whalebone board is unquestionably *the* thing required.

TRAVELING BAGS.

See Chapter ,—Traveling Apparatus.

LIFE-PRESERVING TRAVELING BAGS.

There are different ways of securing all the mouths of the water-proof bags that are noticed in this work, so as to make them air-tight, in which case they may, any of them, be used as life-preservers. The kinds which are most safe, and are most highly approved, are of very nearly the same construction as the one noticed as an improved traveling bag, page 350. They are made more complete by an improvement on the slide fastening, by the addition of two or more clamps, with thumb screws. There is also a self-acting valve tube cemented in this bag, by

which it is inflated with air, although when vulcanized on forms they retain their shape so as to be self-inflated sufficiently for safety.

They are manufactured from a variety of the gum-elastic fabrics combined. See plate , figs.

DOUBLE LIFE-PRESERVING TRAVELING BAGS.

This bag is constructed from two bags of very nearly the same pattern as the one last described. The two are united together at the bottom, and are laced or buckled at the sides, as represented, plate , figs. ; each bag is made air-tight by a separate slide. When laced together, a third compartment is formed for the reception of coarse articles, boots, shoes, &c. When unlaced, it may be used as a life-preserver, and is the most convenient article of this sort for holding one up in the water.

LIFE-PRESERVING EXPANSION TRUNKS AND VALISES.

These are manufactured in the same manner as the expansion trunks and valises described in Chapter XXVIII. A spring of elastic compound is inserted in the straps, by the elasticity of which the two parts of the trunk are drawn together, and the trunk made water and air-tight by compression against the sponge in the top of the lid.

CHAPTER XXX.

ARTICLES FOR THE PRESERVATION OF LIFE AND PROPERTY.

Fire escape rope. Package envelopes. Fruit package envelope. Improved fruit package envelope. Portable boats and pontoons. Portable boat. Portable folding boats. Portable life-boats. Self-inflating portable life-boats. Tubular portable life-boat. Folding frame boat. Box-boat. Batteaux and canoes. Matress boat. Self-inflating pontoons. Self-inflating pontoon raft. Self-inflating wagon floats. Self-inflating balsors and life spars. Life buoys.

Most articles made from these fabrics may come under this head, as in some way tending to this object,* but reference is here made to such as are designed for the preservation of life and property in a manner different from those described in the preceding chapters; viz., such as are used by individuals. Those here treated of are such as may be used for the preservation of the lives of numbers, and for the protection and preservation of provisions and property in commercial transit. All these, together with the others alluded to, are deemed worthy the notice of those who risk, and also of those who insure, property for transportation by sea, and equally so of those who risk or insure lives on the water; as well as of the philanthropist who feels an interest in the progress of improvements, whether he has any pecuniary interest in them or not.

The preservation of life and valuable property on the water, is not now so difficult to accomplish as has heretofore been supposed, nor can a correct idea be formed, from the present prices of articles of this sort now in the market, at how cheap a rate

* Under the above head may very properly be included almost the whole class of articles described Chapter , Medical and Surgical. Some of these are too seldom wanted by any one individual, to warrant the expense of being provided with them all. It may be hoped that the expense of these will in future be so reduced that hospitals at least, and that families may in general have them.

they may be furnished when the manufacture shall be extensively engaged in, with the important improvements in the construction and fastenings of these articles. The personal efforts of the inventor have long been directed to this class of articles, and those connected with the cause of education; and it is his intention to continue them until the usefulness of the articles is so far demonstrated, that others shall duly appreciate the subject.

A suggestion has before been made, that the importance of this subject demands there should be some public or individual philanthropic enterprise engaged in, with ample means for the supply of an assortment of such articles on the lowest possible terms.

To the description of articles which follows, a catalogue of others is added, with reference to their place in other parts of the work.

FIRE-ESCAPE ROPE.

The design of a rope constructed as here described, is to extricate persons from the upper stories of buildings on fire. They are made as represented in plate , fig. , with a cross rope and handles, in order that after the rope is secured and passed from an adjoining building, persons may pass from one building to the other, or descend to the ground; or they are made without handles, like the gymnastic rope hereafter described.

The improvement which is made in this article, consists in inclosing the common hemp rope within an elastic hose, which being loose and stretching upon the rope, it allows one to descend easily upon it without chaffing or burning the hands.

PACKAGE ENVELOPES.

Envelopes have already been noticed in another chapter, as useful in certain cases for the protection of papers. That which is of more general utility, is a water-proof envelope for the safe transportation of merchandize and provisions, especially of those that are perishable, such as flour, fruits, sugar, salt, &c. In consequence of the recent invention of plated canvas, and plated coarse bagging, by the method described, Vol. I., of this work, chapter , it has become practicable to make envelopes so cheap for such purposes, that it is believed this will be found to be one of the most useful applications of gum-elastic.

The cheapest of these envelopes made of coarse canvas or bagging are plated or coated only upon the inside in this way. The wear is thus brought upon the outside of the bagging, which serves to protect the water-proof coating upon the inside from damage. An inner apron or mouth, made of a lighter gum-elastic material, is cemented at the top upon the inside of the envelope. This apron or mouth being tightly fastened, will exclude all wet or dampness. One great economy in the use of such envelopes in addition to their close stowage for shipping or transportation, consists in their adaptation for use a great number of times, for the same or for different purposes, on which account they become valuable to purchasers at retail, either for sale or for use, instead of being wasted or burned, as is often the case with cheap barrels and boxes. See Chapter fig

FRUIT PACKAGE ENVELOPE.

These are made from heavy plated canvas for the same purposes as the envelopes before described. They are intended not only to protect their contents from damage by wet, but also to

preserve fruits and other perishable articles from decay. For this use the air must be exhausted from them by means of an air-pump, a tube being attached to them for this purpose. An iron rim is also attached to the mouth of each part of the envelope, one or both of which has a soft gum-elastic packing cemented upon the edge of it. When the contents are of such a kind as to be liable to injury, from atmospheric or other pressure from without the envelope, it becomes necessary to keep off this pressure, by first placing the contents in a strong box or barrel, or they may be protected by an iron frame within the envelope. See plate fig. .

IMPROVED FRUIT PACKAGE ENVELOPE.

This is made for the same use as the one above described, and in the same way, except that the package is made to fold like self-inflating air work, and is so constructed as to keep pressure off the contents by means of rims or discs of iron or whalebone board cemented in between the section, and by supports or braces, which prevent the envelope from collapsing in the other direction. See plate , fig. .

PORTABLE BOATS AND PONTONS.

Boats were among the first things that were attempted to be made of India rubber, not only in the United States, but also in Europe. But so far as the writer can ascertain, the experiments for this purpose have been chiefly confined to bags of air of various forms. Among these may be noticed the ponton made first for the United States Government, by the Roxbury Company, in 1836, of unvulcanized gum-elastic, and a considerable number made of vulcanized gum-elastic in 1847, which

were intended to be used in the Mexican Campaign. The first manufacture, as might be expected from the nature of the gum, was unsuccessful, and the practical utility of the latter, which were made to be filled with air only, may be considered equally doubtful.

Different attempts have also been made to make portable boats with folding wooden frames of various kinds; but none of these seem to have succeeded further than as curious specimens, or so far as to be used to any considerable extent.

A good portable boat, and particularly one that shall form a life-boat, is obviously a thing much needed. In portable boats savage tribes seem to have succeeded far better than civilized nations. The skill and ingenuity displayed by the native Indians of North America in the construction of the birch canoe may well claim the admiration of the best boat builder, and what is more, this canoe answers perfectly to his wandering propensities. A perfect model for speed, it is so strong that it will carry him over rivers, and lakes, and rapids, with its heaviest ladings, and yet so light that *he carries it* around dangerous rapids and falls, or from one river to another, apparently with as little effort as the bark carries him when launched. His skill in managing these canoes is even more surprising than that which he displays in building them. While they are so buoyant and unsteady as to render it unsafe, even with the greatest caution, for the most experienced seaman who is unacquainted with them to enter one, yet under the elastic step, and artfully-plied paddle of the Indian, it is controlled and moved with astonishing swiftness, as steadily as the sailors long boat.*

Little less deserving of notice is the boat made of skins by the Esquimaux of Labrador, which answers his purpose equally

* This fact is strikingly illustrated in the porpoise shooting of a tribe of Naragansetts at Eastport, Maine. They will shoot with the rifle and take into their canoes, in a rough sea, a number of porpoises weighing hundreds each. The fish sink so soon after shooting that no white man can perform the feat of reaching one in time, to say nothing of shipping him into a birch canoe. The Indians hunt these fish in summer, for the oil which they often exchange with their white neighbors for dried codfish in winter, when with the same amount of labor they might catch twenty times the quantity of fish with the hook. The same preference for hunting, leads them to spearing salmon at night, instead of catching fish with the hook, an occupation which they are said to despise.

well, not only as a boat but as a life-boat which he so much needs. That so little has been done in this art by civilized nations, would seem only to be accounted for by the fact that their rivals were so far in advance, as to baffle their attempts to equal them, or that they have not had the material suitable to build with. Considering the suitableness of vulcanized fabrics for such purposes, and the improvements of the writer and others, in the construction of the boats hereafter noticed, it may be hoped that better success will attend this manufacture in future; and it will be little to the credit of the India rubber manufactories, if they are not able to make better portable and life-boats than have yet been built. A few only of the various kinds which may be made of these materials are here noticed.

PORTABLE BOAT.

A very light and strong portable boat is made from India rubber whalebone board in sheets, in the following manner. The sheets of board are cemented together upon a model or form of the shape required. It is next taken off, and placed inside another model of the same shape, in which it is vulcanized. The knees, gunwale, and braces are made of wood or iron covered with caoutchouc whalebone, and are cemented in before vulcanizing.

PORTABLE FOLDING BOATS.

The portable folding boats that are deemed most deserving of notice, are the two following, as represented in the plate , figs. 1 and 2. The plan upon which these two are made is very similar, but they are folded together in different ways. That represented by fig. 1 occupies, when folded, less space in length than No. 2, but more in thickness. The covering of them both

is made of plated canvas. The ribs or knees and braces which are made either of iron or wood, covered with caoutchouc whalebone, are cemented to the boat cover upon the inside. The ribs or knees are kept in place when the boat is opened by braces extending from one rib or knee to the other, and also by a keel-piece in the bottom of the boat. The ribs, keel, and braces of the boat, which are represented by fig. 2 are cemented on the inside of the boat in the same way as those of fig. 1, but they are made to run longitudinally with the boat; when folded, the ribs fit one within the other, so that this boat occupies a smaller space in thickness than fig. 1; when opened, the ribs are supported by braces extending from the keel to the gunwale.

PORTABLE LIFE-BOAT.

The portable life-boat represented by fig. , is made of caoutchouc whalebone board, and constructed in the same way as the ship's boats described in Chap. ; the gunwales, ribs, and seats being made of tubes or cylinders of whalebone board, of such dimensions as will render the boats more or less buoyant in proportion to their size. Compartments of the same material are made in the bow and stern of the boat, air-tight. The keel is also formed of a cylinder, so arranged that it may be filled with water, to give ballast to the boat, and pumped out when necessary. See plate , fig.

SELF-INFLATING PORTABLE LIFE-BOAT.

These are also of two kinds, resembling each other as the two portable boats before described. They are, in fact, the same boat, with the addition of a tube or air-chamber made of plated fabrics, between the knees or ribs of the boat. Instead, however, of the ribs or knees being made of iron or wood, they may be dispensed with by making the divisions between the tubes or air-chambers of caoutchouc whalebone, of sufficient strength to

keep the boat firm without other ribs ; each of the air-chambers is inflated by a separate tube, and upon being distended, the whole boat is self-inflated, and is prevented from collapsing, in the same manner as the other self-inflating air-work pontoons, life-buoys, &c., which are stayed by whalebone board between the compartments. See plate , figs.

TUBULAR PORTABLE LIFE-BOATS.

Tubular portable boats and life-boats, represented in plate , fig. , are formed of tubes, from one to two inches in diameter. These tubes, which are made of whalebone board, are cemented together lengthwise upon a model of a boat, after which they are stayed, finished, and vulcanized in another model, in the same manner as the ship's boats described, Chap. . These boats, in consequence of each tube being made separately water-tight, are more safe as life-boats, besides being stronger than those made of sheets of whalebone, although not so light and portable.

FOLDING FRAME BOAT.

This is a form of boat, the frame of which is made of wood, united by joints and hinges, as represented by plate , fig. . The cover, which is put on and off as required, is made of plated gum-elastic canvas. It is light and convenient, but somewhat objectionable, chiefly on account of the number of pieces and joints in the frame. It is rendered a safe boat, or life-boat, by air-chambers cemented to the top of the cover. See plate , fig.

BOX BOAT.

This boat is made of caoutchouc whalebone in two equal parts, which may be connected by hinges and shutter bolts. When shut together, they form a serviceable box or trunk. See plate , Chap.

BATTEAUX AND CANOES.

Batteaux and canoes of different forms, made of caoutchouc whalebone board, are both light enough to be portable and strong enough for common use. They are constructed upon the same general plan as the other boats before specified, which are made from caoutchouc whalebone and whalebone board, in sheets. See plate , fig. .

MATRESS BOAT.

The matress boat is one which, when folded, forms a good ship's matress, and has been noticed as such, Chap. , p. .

SELF-INFLATING PONTOONS.

These were among the assortment of articles that were exhibited at the London World's Fair of 1851, for which a council medal was awarded to the writer. It is a kind of pontoon before alluded to as being an improvement upon those filled with air only. They are made of plated canvas, and are commonly about fourteen feet in length and eighteen inches in diameter, being made either round or square. Each pontoon is composed of from twelve to eighteen separate chambers or compartments, each of these chambers is self-inflated by a separate tube or orifice. It is inflated simply by pulling the ends of the pontoon apart; a sheet of caoutchouc whalebone board, of the size of the pontoon, is cemented in between every two compartments. These boards serve to keep the pontoons from collapsing, and when fitted for use they are prevented from collapsing lengthwise, by a spar fastened upon each one or between every two pontoons, when used in pairs.

The construction of these pontoons is such, that they will not collapse or be rendered unsafe in consequence of a leak, unless it happens to be a large one upon the water-line; neither is it indispensable that the tube or orifice should be stopped, in order to keep them inflated. See plate , fig. .

SELF-INFLATING PONTOON RAFT.

This raft may be formed from any description of air cylinder represented in plates , figs. . But the kind which is decidedly best adapted for this use, is the self-inflating pontoon described in this chapter.

In order to form one of these rafts, two of these pontoons or balsors are inflated and kept distended by a spar between them, to which they are fastened at each end. They are kept at any suitable distance apart by a transverse spar at both ends of the raft.

An India rubber canvas is drawn under them, which enables them to carry a large freight in smooth water without danger of its being wet; or, if the canvas is made larger, and is allowed to fall far below the cylinders, the raft will float a much larger freight or a much greater number of persons safely, in proportion to the bulk of the freight.

Rafts of this kind may be recommended as the surest and most economical means of saving the greatest number of lives and the largest amount of property, in cases of accident so destructive to both, and so very frequent upon navigable rivers and lakes. They are not expensive, and occupy but small space—say three feet by six—for one large enough to save the lives of three hundred persons. They are extremely light. There is not the slightest danger of the cylinders collapsing, and they can be fitted for use and launched in two or three minutes, without difficulty.

SELF-INFLATING WAGON FLOATS.

The cylinders for these floats are made in every particular like the pontoons last described, and may be considered an improvement upon the wagon float invented by Col. Staunton, described page . So far as the security of the floats against collapsing, and the facility of inflating them are concerned, they are unquestionably an improvement. The method of attaching them for supporting the wagons is the same as with the plain cylinder.

SELF-INFLATING BALSORS AND LIFE-SPARS.

They are made in every respect like the self-inflating pontoons and other self-inflating articles, in which the compartments are prevented from collapsing by sheets of caoutchouc whalebone board cemented between them, each compartment being inflated by a separate tube. They are, however, made of smaller dimensions, or from eight to twelve inches diameter and from twelve to twenty feet in length. They are designed to be used as life-spars, or to be fastened upon boats to prevent them from swamping.

LIFE BUOY.

See Chapter XI.